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Paediatric Reference Computational Phantoms

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[GUEST] Editorial

To be drafted

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Paediatric Reference Computational Phantoms

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ICRP Publication xxx

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Approved by ICRP in DATE

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19 **Abstract** – This report describes the development and intended use of a series of ten computational

20 phantoms representing the reference male and female at newborn, 1-year-old, 5-year-old, 10-year-

21 old, and 15-year-old as defined in Publication 89. These phantoms have been formally adopted by

22 the ICRP for use within ICRP Committee 2 in the development of age-dependent dose coefficients

23 following the 2007 Recommendations. They are presented in this report in the very same voxelized

24 structures and tissue ID numbers as given in *Publication 110* for the adult reference computational

25 phantoms. These paediatric phantoms have been used by Task Group 90 of ICRP Committee 2 in

26 the development of age-dependent dose coefficients representing external exposures to

27 contaminated air, water, and soil. They have also been used by Task Group 96 of ICRP Committee

28 2 in the development of age-dependent specific absorbed fractions for internally emitted photons,

29 electrons, alpha particles, and neutrons, in a manner similar to the adult SAF (Specific Absorbed

30 Fraction) values given in *Publication 133*. These age-dependent SAF values are currently being

31 utilized by Task Group 96 in the preparation of age-dependent dose coefficients for radionuclide

32 ingestion and inhalation as part of the forthcoming EIR (Environmental Intakes of Radionuclide)

33 publication series which updates the dose coefficients of ICRP *Publications 56, 67, 71, and 72*.

34 Chapter 1 summarises the main reasons for constructing these phantoms – voxel phantoms that

35 comply with the reference anatomical characteristics of the non-adult reference individuals

36 presented in *Publication 89*. Chapter 2 reviews the body size/shape and organ-specific

37 specifications of the ICRP paediatric reference phantoms. Chapter 3 presents in detail the methods

38 of their construction which includes 9 specific steps in their development: (1) selection of CT

39 tomographic data, (2) segmentation of those CT images, (3) body contour and organ modelling via

40 NURBS/PM surfaces, (4) adjustments of outer body contour to match total body mass, (5)

41 adjustments of individual organ values to match reference masses, (6) subdivision of the skeletal

42 tissues, (7) voxelization of the NURBS/PM surfaces, (8) voxel retagging for lymphatic nodes and

43 skeletal muscle, and (9) further modifications to bring the series of paediatric phantoms into a

44 structure identical to that original established for the adult phantoms of *Publication 110*. Chapter

45 4 follows with a description of the ICRP paediatric reference phantoms including their main

46 characteristics, skeletal source/target regions, regional blood distribution, and phantom limitations.

47 The report is supported by a series of annexes. Annex A provides details on tissue ID numbers,

48 tissue media, mass densities, and organ locations by both coordinate position and voxel count.

49 Annex B provides a complete list of the various age-dependent and gender-dependent tissue media,

50 their phantom masses, and elemental compositions. Annexes C and D provide a listing of all source

51 and target regions, respectively, needed for internal as well as external dosimetry applications.

52 Annexes E and F provide depth distributions and organ pair distance distributions, respectively, in

53 a manner similar to that provided in *Publication 110* for the adult phantoms. Annex G provides
54 cross-sectional images – sagittal, coronal, and transverse planes. Finally, Annex H gives a
55 description of the electronic files available for download and use of each of the 10 paediatric
56 reference computational phantoms.

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59 **Keywords:** Computational phantoms, voxel models, paediatric reference individuals

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PREFACE

69

70 This report provides a summary of the methods and procedures used to create a series of voxel-
71 based computational phantoms corresponding to non-adult series of reference persons outlined in
72 *Publication 89*. The phantom series consists of 10 phantoms – male and female models of the
73 reference newborn, 1-year-old, 5-year-old, 10-year-old, and 15-year-old. The methods and
74 procedures used in this activity have been reported in numerous peer-reviewed publications. These
75 phantoms are designed specifically for calculation of the radiological protection quantities
76 corresponding to the effective dose concept of the 2007 Recommendations of the Commission.
77 The phantom format structure, organ and tissue identification numbers, and electronic files are
78 purposefully developed to be identical to those established in *Publication 110* for the
79 Commission’s reference adult male and adult female phantoms, thus allowing for ease of use in
80 applications requiring organ dose assessment across the full range of reference ages. The phantoms
81 are presented to the radiation protection community in numerical format, with identification of
82 source and target regions of the body in electronic files which may be downloaded from the ICRP
83 and SAGE websites.

84

85 The membership of the Task Group 96 on Computational Phantoms and Radiation Transport
86 (CPRT) of ICRP Committee 2 was follows:

87

W.E. Bolch (Chair)	C.H. Kim	T. Sato
J.G.S. Hunt	C. Lee	M. Zankl
D.W. Jokisch	N. Petoussi-Henss	

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89 The corresponding members were:

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95 The membership of ICRP Committee 2 during the period of preparation of this report was:

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F. Paquet (Vice-Chair)	C.H. Kim	T. Sato
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V. Berkovskyy	J. Li	A. Ulanowski
E. Blanchardon	M.A. Lopez	F. Wissmann
A. Giussani		

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98

GLOSSARY

99

100 Absorbed dose, D

101 The absorbed dose is given by

$$102 \quad D = \frac{\overline{d\varepsilon}}{dm}$$

103 where $\overline{d\varepsilon}$ is the mean energy imparted by ionising radiation to matter of mass dm . The
 104 International System of Units (SI) of absorbed dose is joule per kilogramme (J kg^{-1}), and
 105 its special name is gray (Gy).

106 Active (bone) marrow

107 Active marrow is haematopoietically active and gets its red colour from the large numbers
 108 of erythrocytes (red blood cells) being produced. Active bone marrow serves as a target
 109 region for radiogenic risk of leukaemia.

110 Bone marrow

111 See also ‘Active (bone) marrow’; ‘Inactive (bone) marrow’.

112 Bone marrow is a soft, highly cellular tissue that occupies the cylindrical cavities of long
 113 bones and the cavities defined by the bone trabeculae of the axial and appendicular
 114 skeleton. Total bone marrow consists of a sponge-like, reticular, connective tissue
 115 framework called stroma, myeloid (blood-cell-forming) tissue, fat cells (adipocytes), small
 116 accumulations of lymphatic tissue, and numerous blood vessels and sinusoids. There are
 117 two types of bone marrow: active (red) and inactive (yellow) where these adjectives refer
 118 to the marrow’s potential for blood cell element production (haematopoiesis).

119 Cortical (bone) marrow.

120 The marrow contained in the medullary cavities in the shafts of the long bones.

121 Effective dose, E

122 In accordance with the generic definition of effective dose in *Publication 103*, the effective
 123 dose is calculated as:

$$124 \quad E = \sum_T w_T \left[\frac{H_T^M + H_T^F}{2} \right]$$

125 where H_T^M and H_T^F are the equivalent doses to the tissues or organs r_T of the reference
 126 male and female at a given reference age, respectively, and w_T is the tissue weighting factor
 127 for target tissue T, with $\sum_T w_T = 1$. The sum is performed over all organs and tissues of the

128 human body considered to be sensitive to the induction of stochastic effects. Since w_R and
 129 w_T are dimensionless, the unit for effective dose is the same as for absorbed dose, $J\ kg^{-1}$,
 130 and its special name is sievert (Sv).

131 Endosteum (or endosteal layer)

132 A 50- μ m-thick layer covering the surfaces of the bone trabeculae in regions of trabecular
 133 spongiosa and those of the cortical surfaces of the medullary cavities within the shafts of
 134 all long bones. It is assumed to be the target region for radiogenic bone cancer. This target
 135 region replaces that previously introduced in *Publications 26* and *30* – the bone surfaces –
 136 which had been defined as a single-cell layer, 10 μ m in thickness, covering the surfaces of
 137 both the bone trabeculae and the Haversian canals of cortical bone.

138 Equivalent dose (H_T)

139 The equivalent dose to a tissue or organ is defined as:

140

$$142 \quad H_T = \sum_R w_R D_{T,R}$$

141

143 where w_R is the radiation weighting factor for radiation type R, and $D_{T,R}$ is the organ
 144 absorbed dose from radiation type R in a tissue or organ r_T of the reference male or female.
 145 Since w_R is dimensionless, the unit for the equivalent dose is the same as for absorbed dose,
 146 $J\ kg^{-1}$, and its special name is sievert (Sv).

147 Identification (ID) number

148 Number assigned unequivocally to each individually segmented organ/tissue.

149 Inactive (bone) marrow

150 In contrast to the active marrow, the inactive marrow is haematopoietically inactive (i.e.
 151 does not directly support haematopoiesis). It gets its yellow colour from fat cells
 152 (adipocytes) which occupy most of the space of the bone marrow framework.

153 Marrow cellularity

154 The fraction of bone marrow volume in a given bone that is haematopoietically active.
 155 Age- and bone-site-dependent reference values for marrow cellularity are given in Table
 156 41 of *Publication 70*. As a first approximation, marrow cellularity may be thought of as 1
 157 minus the fat fraction of bone marrow.

158 Red (bone) marrow

159 See ‘Active (bone) marrow’.

160 Reference Male and Reference Female (Reference Individual)

161 An idealised male or female with anatomical and physiological characteristics defined by
 162 ICRP for the purpose of radiological protection. Reference individuals are defined in

163 *Publication 89* for both the male and female at ages of the newborn, 1-year-old, 5-year-
164 old, 10-year-old, 15-year-old, and adult. Consequently, there exist twelve (12) Reference
165 Individuals within the ICRP System of Radiation Protection.

166 Reference Person

167 An idealised person, for whom the equivalent doses to organs and tissues are calculated by
168 averaging the corresponding doses of the Reference Male and Female. The equivalent
169 doses of the Reference Person are used for the calculation of the effective dose. There are
170 thus six (6) Reference Persons within the ICRP System of Radiological Protection, one at
171 each of the reference ages defined in *Publication 89*.

172 Reference parameter value

173 The value of a parameter, factor or quantity that is regarded as valid for use in dosimetric
174 calculations and recommended by ICRP. These values are fixed and are not subject to
175 uncertainties.

176 Response function

177 A function representing the absorbed dose in a target region per particle fluence in the
178 region, derived using models of the microscopic structure of the target region geometry,
179 and the transport of the secondary ionizing radiations in those regions.

180 Source region (r_s)

181 Region of the body containing the radionuclide. The region may be an organ, a tissue, the
182 contents of the alimentary tract or urinary bladder, or the surfaces of tissues as in the
183 skeleton and the respiratory tract.

184 Specific absorbed fraction (SAF), $\Phi(r_T \leftarrow r_S, E_{R,i})$

185 Fraction of radiation R of energy $E_{R,i}$ emitted within the source region r_S that is absorbed
186 per mass in the target region r_T .

187 Spongiosa

188 Term referring to the combined tissues of the bone trabeculae and marrow tissues (both
189 active and inactive) located beneath the cortical bone cortices across regions of the axial
190 and appendicular skeleton. Spongiosa is one of three bone regions defined in *Publication*
191 *110* reference phantoms, the other two being cortical bone and medullary marrow of the
192 long bone shafts. As the relative proportions of trabecular bone, active marrow, and
193 inactive marrow vary with skeletal site and reference phantom age, the homogeneous
194 elemental composition and mass density of spongiosa are not constant, but vary with
195 skeletal site and phantom age.

196 S coefficient (radiation-weighted), $S_w(r_T \leftarrow r_S)$

197 The equivalent dose to target region r_T per nuclear transformation of a given radionuclide
198 in source region r_S , Sv (Bq s)⁻¹, for the reference male and reference female at a given
199 reference age.

201
$$S_w(r_T \leftarrow r_S) = \sum_R w_R \sum_i E_{R,i} Y_{R,i} \Phi(r_T \leftarrow r_S, E_{R,i})$$

200 where:

202 $E_{R,i}$ is the energy, in joules, of the i^{th} radiation of type R emitted in nuclear
203 transformations of the radionuclide;

204 $Y_{R,i}$ is the yield of the i^{th} radiation of type R per nuclear transformation, (Bq s)⁻¹,

205 w_R is the radiation weighting factor for radiation type R (Table 1), and

206 $\Phi(r_T \leftarrow r_S, E_{R,i})$ is the specific absorbed fraction (SAF), defined as the fraction of energy
207 $E_{R,i}$ of radiation type R emitted within the source region r_S that is absorbed per mass in the
208 target region r_T , kg⁻¹.

209 For reference adult, no change in anatomical parameters with time (age) are considered
210 and therefore, S_w is invariant with respect to time and its value represents either the
211 equivalent dose rate (Sv s⁻¹) per activity (Bq), or the equivalent dose (Sv) per nuclear
212 transformation (Bq s) in the target region. For paediatric reference persons, and for dose
213 integration over several years, the specific absorbed fraction, and thus the S coefficient,
214 are both considered to be function of time to allow for age-dependent changes in source
215 and target region mass and, for cross-dose, their separation within the body.

216 Target region (r_T)

217 Organ or tissue region of the body in which a radiation absorbed dose is received.

218 Target tissue (T)

219 Organs or tissues in the body for which radiation weighting factors are assigned in the
220 effective dose. In many cases, each target tissue T corresponds to a single target region r_T .
221 In the case of extrathoracic airways, thoracic airways, colon, and lymphatic nodes,
222 however, a fractional weighting of more than one target region r_T defines the target tissue
223 T.

224 Trabecular (bone) marrow

225 The marrow contained in the spongiosa regions of all bones.

226 Voxel phantom

227 Computational anthropomorphic phantom based on medical tomographic images in which
228 the anatomy is described by small three-dimensional volume elements (voxels) specifying
229 the organ or tissue to which they belong.

230 Yellow (bone) marrow

231 See 'Inactive (yellow) marrow'.

232

233

1. INTRODUCTION

234 (1) In 2009, the Commission issued *Publication 110* which described the development and
235 subsequent adoption of two computational voxel phantoms representing the reference adult male
236 and reference adult female (ICRP, 2009). These phantoms were based on medical image data of
237 real people and were consistent with the information given in *Publication 89* on the reference adult
238 anatomical and physiological parameters (ICRP, 2002). The reference voxel phantoms were
239 constructed following modification of previously existing voxel models (Golem and Laura) of two
240 individuals whose body height and mass closely resembled the reference data. Internal organ
241 masses of both models were subsequently adjusted to the ICRP data on the reference adult male
242 and reference adult female, without significant alterations to their realistic anatomy. *Publication*
243 *110* describes the methods used for this process and the characteristics of the resulting voxel
244 phantoms.

245 (2) Since their development and adoption by the Commission, the *Publication 110* adult
246 reference phantoms have been used in a number of task group activities within ICRP Committee
247 2. In 2010, the Commission issued *Publication 116* reporting dose coefficients for both organ
248 equivalent dose and effective dose following occupational exposures to externally incident fields
249 of photons, electrons, positron, neutrons, and helium ions (ICRP, 2010). This report represented
250 the first use of the new reference adult voxel phantoms by Committee 2. The *Publication 110*
251 phantoms were additionally used to construct external dose coefficients relevant to both cosmic
252 ray exposures (ICRU, 2010) and the radiation fields in the space environment (ICRP, 2013). In
253 *Publication 133*, the Commission reported adult reference values for specific absorbed fractions
254 for internally emitted photons, electrons, alpha particles, and neutrons (the latter associated with
255 internal emitters decaying via spontaneous fission) (ICRP, 2016a). These adult SAF values were
256 then used in the computation of dose coefficients of both equivalent organ dose and effective dose
257 following both ingestion and inhalation of radionuclides in occupational settings as described in
258 *Publication 130* (OIR Part 1) (ICRP, 2015). Dose coefficients for internal exposures of the
259 reference adults are given in the Occupational Intakes of Radionuclides (OIR) series of documents
260 which presently include *Publication 134* (OIR Part 2) (ICRP, 2016b) and *Publication 137* (OIR
261 Part 3) (ICRP, 2017).

262 (3) The current report extends the series of ICRP reference phantoms to include those of the
263 male and female reference newborn, 1-year-old, 5-year-old, 10-year-old, and 15-year-old. These
264 paediatric reference phantoms are presently being used in two series of Committee 2 activities.
265 The first is the establishment of organ and effective dose coefficients for environmentally localized
266 radionuclides to include air submersion, water immersion, and ground exposure. In this Committee
267 2 Task Group activity, both the *Publication 110* adult phantoms are used, as well as the paediatric
268 reference phantoms of this report. The second activity is the development of updated dose
269 coefficients for environmental intakes of radionuclides (ingestion and inhalation) to include all
270 members of the general public – reference adults, adolescents, and children. An extension of
271 *Publication 133* describing photon, electron, alpha particle, and internal neutron specific absorbed
272 fractions in the ICRP paediatric phantom series is presently under development.

273

274
275

2. SPECIFICATIONS OF THE ICRP PEDIATRIC REFERENCE PHANTOMS

276 (4) The voxel phantoms used for calculation of energy deposition in body organ and tissues
277 (target regions) following the 2007 Recommendations should accommodate all organs and tissues
278 that are relevant to the assessment of human exposure to ionizing radiation for radiological
279 protection purposes. These target regions include: active bone marrow, adrenal glands, brain,
280 breast, colon, endosteal tissues of the skeleton, extrathoracic (ET) airways, eye lens, gall bladder,
281 heart, kidneys, liver, lungs, lymphatic nodes, skeletal muscle, oesophagus, oral mucosa, ovaries,
282 pancreas, prostate gland, salivary glands, skin, small intestine, spleen, stomach, testes, thymus,
283 urinary bladder, and uterus. Furthermore, additional target regions have been identified within the
284 Human Respiratory Tract Model and Human Alimentary Tract Model. These target regions
285 include: alveolar–interstitium, basal cells of the anterior and posterior nasal passages and pharynx,
286 basal cells of bronchi, lymph nodes of ET and thoracic regions, secretory cells of bronchi and
287 bronchioles, and tongue and tonsils.

288 (5) When radioactive material is incorporated into the body, those organs, tissues, and body
289 regions where radionuclides reside or pass through become source regions that irradiation other
290 (target) regions. Many regions are both source and target regions. Additional source regions are
291 located in the alimentary and respiratory tracts, as well as in the skeleton. Certain individual
292 anatomical regions have to be considered differently depending on the rate with which the material
293 passes through or is cleared from them. These additional source regions include: organ cavity,
294 teeth surfaces, teeth volumes, oesophagus (fast, slow), stomach content, small intestine content,
295 right colon (content, wall), left colon (content, wall), rectosigmoid colon (content, wall), gall
296 bladder content, urinary bladder content, nasal passages (anterior and posterior surfaces), pharynx,
297 sequestered ET₂ region, bronchi (fast, slow, bound, sequestered), bronchi, bronchioles (fast, slow,
298 bound, sequestered), blood vessels (head, trunk, legs, and arms), cortical bone (surface, volume),
299 trabecular bone (surface, volume), and inactive bone marrow. To support applications to the
300 kidney dosimetry in nuclide medicine, the models of the kidneys in the reference paediatric
301 phantoms include separate regions for the renal cortex, renal medulla, and renal pelvis. As was
302 done for the adult reference phantoms of *Publication 110*, the skeletal tissues of the reference
303 paediatric phantoms are given as regions of cortical bone, spongiosa, and medullary marrow.
304 Voxel regions of spongiosa thus represent a homogenous mixture of trabecular bone, active bone
305 marrow, and inactive bone marrow, whose mass fractions vary with skeletal bone location and
306 phantom age and, for the 15-year-old, gender.

307 (6) The body morphometry specifications of the ICRP paediatric reference individuals are
308 given in Table 1 as reported in Table 2.9 of *Publication 89* (ICRP, 2002). The specifications of
309 reference body size and shape are thus limited to only total body mass and standing height. Body
310 surface area is additionally specified, but the reference values given in Table 2.1 derive from the
311 expression reported in Gehan and George (1970) whose input is standing height and body mass;
312 thus, body surface area is not an independent parameter for phantom construction. Reference
313 values of organ mass are further given in Table 2.8 for the full series of 12 reference individuals –
314 male and female at newborns, 1-year-olds, 5-year-old, 10-year-old, 15-year-old, and adults. For
315 the reference newborn, 1-year-old, 5-year-old, and 10-year-old, reference values of standing height
316 and total body mass are shown to be equivalent for both the reference male and reference female.
317 This feature of the paediatric reference individuals – equivalent body size of the male and female

318 at each reference age – also extends to reference organ masses. The few exceptions are noted in
 319 Table 2.8 of *Publication 89* and include different male and female brain masses at ages of 5 and
 320 10 years, and different male and female thymus masses at 10 years of age.¹ For the 15-year-old
 321 male and female, *Publication 89* indicates distinctive reference values for organ masses, standing
 322 heights, and total body masses. These features of uniformity of male and female reference
 323 individuals at ages below 15 years were utilized in the development of the corresponding reference
 324 phantoms include CT images of only one gender were selected as the source anatomy for phantom
 325 construction.

326
 327 Table 2.1. Reference values for standing height, body mass, and total body surface area of the
 328 ICRP reference individuals – both paediatric and adult.

Age	Height (cm)		Mass (kg)		Surface Area (m ²)	
	Male	Female	Male	Female	Male	Female
Newborn	51	51	3.5	3.5	0.24	0.24
1 Year	76	76	10	10	0.48	0.48
5 Year	109	109	19	19	0.78	0.78
10 Year	138	138	32	32	1.12	1.12
15 Year	167	161	56	53	1.62	1.55
Adult	176	163	73	60	1.90	1.66

329
 330
 331 (7) A list of all organs, tissues, and regions that were defined in the paediatric reference
 332 phantom series, and have been assigned an individual organ identification number, is given in
 333 Annex A. Annex B gives a list of different tissue types of which the organs and tissues consist,
 334 along with their elemental compositions. Annex C presents a list of all source organs and regions,
 335 together with the organ identification numbers by which they are represented. Annex D gives this
 336 same information for target organs and tissues.

337

¹Target masses for brain in the 5-year-old and 10-year-old male and female phantoms, and for the thymus in the 10-year-old male and female phantoms, were thus assigned as the average of the reference male and female organ masses from *Publication 89*.

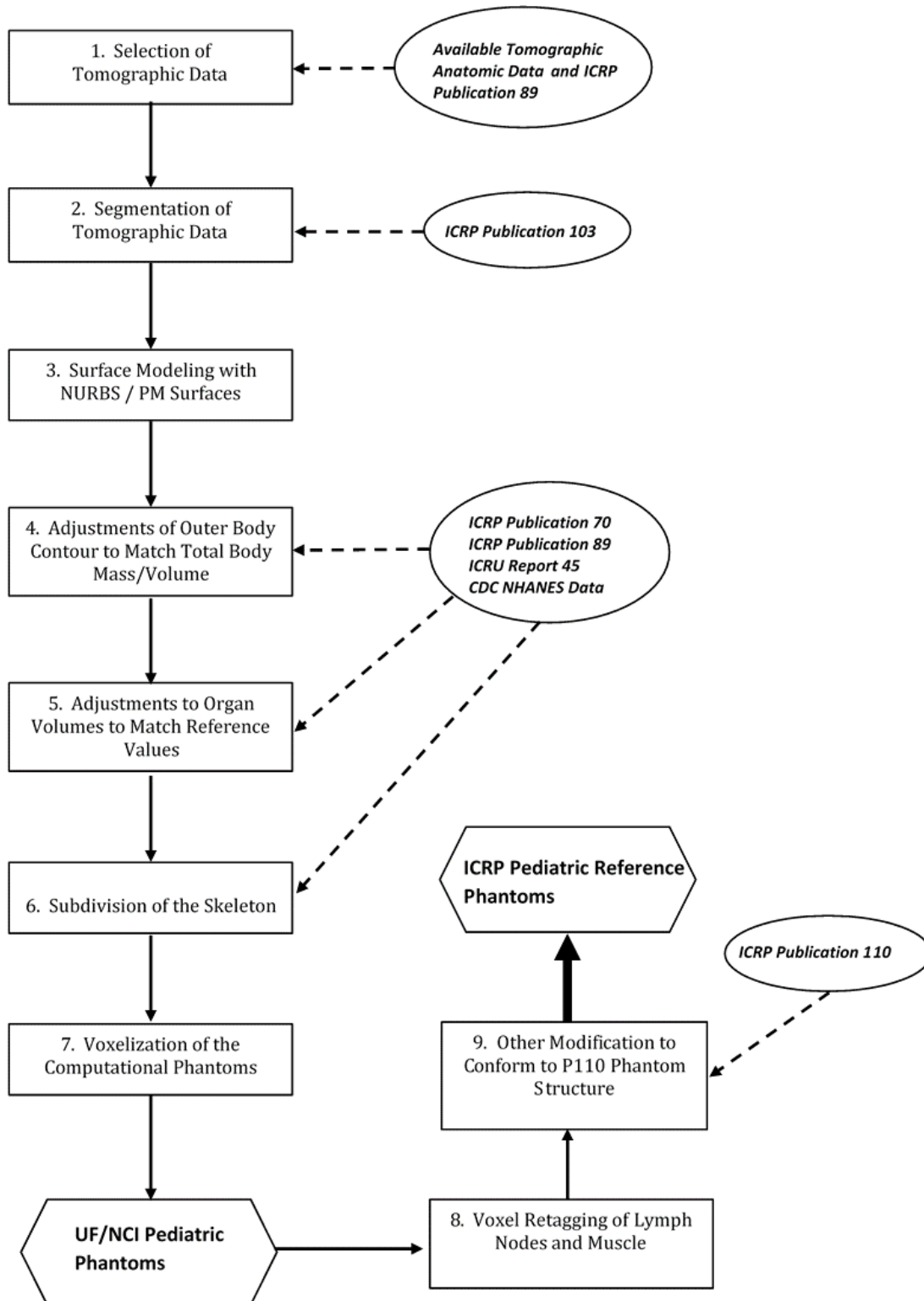
338 **3. DEVELOPMENT OF THE ICRP PAEDIATRIC REFERENCE**
339 **PHANTOMS**

340 (8) The paediatric reference computational phantoms of this report were derived from a
341 corresponding series of computational phantoms developed at the University of Florida (UF) and
342 later at the U.S. National Cancer Institute (NCI) (Lee et al., 2010). In this section, we review (1)
343 the source of CT tomographic data for UF/NCI phantom construction, (2) the techniques applied
344 to create the UF/NCI phantoms consistent with the anatomic specifications of *Publication 89* and
345 other morphometry data, and (3) modifications applied to the UF/NCI phantoms to bring them into
346 a format consistent with those of the adult male and female reference computational phantoms of
347 *Publication 110*.

348 **3.1. Overview of the paediatric phantom construction methodology**

349 (9) The process by which the paediatric reference phantoms were constructed is outlined in
350 schematic form in Figure 3.1. Step 1 involved the selection of tomographic data for phantom
351 construction, followed by manual segmentation of that data for identification of individual organs
352 and tissues in Step 2. This second step effectively results in a traditional voxel phantom derived
353 from the source CT image set. In the present work, however, an additional step – Step 3 – was
354 employed whereby the voxelized surfaces of the outer body contour and all internal organs were
355 modelled using NURBS and polygon mesh surfaces to smooth them in a 3D manner. A further
356 advantage of this approach was that targeted organ volumes could be readily achieved through
357 adjusting the NURBS or polygon mesh surfaces normally outward or inward, in contrast to process
358 employed in *Publication 110* which required the removal or addition of individual layers of voxels
359 to decrease or increase, respectively, a given organ volume. Steps 4 and 5 thus allowed modelling
360 of reference body morphometry, and reference internal organ volumes, respectively. Step 6
361 resulting in a conversion of a homogeneous model of the skeletal bones to those which have
362 separate regions of cortical bone, trabecular spongiosa, and medullary marrow. At the time of their
363 development, radiation transport codes did not yet have the capability to transport radiation
364 particles directly within the NURBS/polygon mesh structure, and so Step 7 included voxelization
365 – a process by which voxels are inserted interior to the polygon mesh or NURBS surfaces of body
366 and body organs [see further description given in Lee et al. (2010)]. The advantage here, however,
367 is that the voxel size applied in Step 7 is user-defined, and not limited to the voxel dimensions of
368 the original CT image set. The final step – Step 8 - involved retagging of voxels to provide a model
369 of the skin, lymphatic nodes, and skeletal muscle. Step 9, the final activity of phantom
370 development, included further modifications of these reference voxel phantoms to bring them into
371 full compliance with the phantom structure of *Publication 110*. These steps are further described
372 below.
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Fig. 3.1. Schematic for constructing the pediatric series of male and female computational reference phantoms.

378 **3.2. Source tomographic data for paediatric reference phantom construction**
379 **(Step 1)**

380 (10) Computed tomography image data used for phantom construction are summarized in Table
381 3.1. CT images for phantom construction came from one of two sources: (1) prospective images
382 of cadavers (newborn model), or (2) retrospective review and image retrieval from radiology
383 archives at the UF Health Children’s Hospital (all other reference ages). Prior to final adoption for
384 phantom construction, CT images were reviewed by the Chief of Paediatric Radiology at the
385 University of Florida for any gross abnormalities which would preclude them for representing
386 “normal” paediatric anatomy. While CT images of male and female patients were used in the
387 construction of 15-year-old male and female reference phantoms, respectively, images from only
388 one gender were used as source data for the construction of the newborn (female data), 1-year-old
389 (female data), 5-year-old (male data), and 10-year-old (male data) reference phantoms. At each
390 reference age, the phantom of the opposite gender was thus created via removal and re-insertion
391 of the appropriate sex organs in their NURBS/PM format (see Section 3.2).

392 (11) The development of the male and female newborn reference phantoms is described in
393 Nipper et al. (2002) and in Lee et al. (2007). CT source data for their construction consisted of 485
394 CT images of a 6-day-old female cadaver. The patient died in an attempt to correct congenital
395 abnormalities of the great vessels, and was imaged within 24 hours of death. The image data were
396 contiguous with no gaps or data overlaps. Each slice was saved as a 512 x 512 image with an in-
397 plane pixel resolution of 0.586 mm x 0.586 mm and a 1-mm slice thickness. The cadaver mass had
398 been recorded at 3.83 kg at time of death.

399 (12) The development of the male and female reference phantoms at ages of 1-year-old, 5-year-
400 old, and 10-year-old is described in Lee et al. (2010). The 1-year-old reference phantoms were
401 created based upon head CT images of a 2-year-old female (3.79 x 0.379 x 4.5 mm³ resolution)
402 and chest-abdomen-pelvis (CAP) images of a 1-year-old female (0.406 x 0.406 x 3 mm³
403 resolution). The 5-year-old reference phantoms were created based upon head and CAP CT images
404 of the same patient – a 4-year-old female (0.451 x 0.451 x 5 mm³ resolution). The 10-year-old
405 reference phantoms were created based upon head CT images of a 12-year-old male and CAP
406 images of an 11-year male (both at 0.469 x 0.469 x 6 mm³ resolution). For each phantom, two
407 supplemental image sources were additionally applied to phantom construction. These included
408 higher-resolution CT images of the cervical spine of a 15-year-old female (0.210 x 0.210 x 0.75
409 mm³) and CT images of the arms and legs of an 18-year male cadaver (1 x 1 x 1 mm³ resolution).
410 Both the cervical spine, arm, and leg models were proportionally scaled to target reference body
411 morphometry data as described below.

412 (13) The development of the male and female 15-year-old reference phantoms is described in
413 Lee et al. (2008). The 15-year-old male reference phantom was based upon head CT images of an
414 18-year-old male (1 x 1 x 1 mm³ resolution) and CAP CT images of a 14-year-old male (0.625 x
415 0.625 x 6 mm³ resolution). The 15-year-old female reference phantom was based upon head CT
416 images of a 15-year female (0.449 x 0.449 x 4.5 mm³) and CAP CT images of a 14-year female
417 (0.742 x 0.742 x 6 mm³).

418 3.3. Construction of the paediatric reference phantom series (Steps 2 – 5)

419 (14) CT images from all data sets of Table 3.1 were imported into the 3D image segmentation
420 software 3D-Doctor™ where organs and tissues were segmented and later imported into the
421 NURBS (non-uniform rationale B-spline surface) modelling tool Rhinoceros 4.0™. As described
422 in Lee et al. (2010), most organs and tissues were modelled as NURBS surfaces with the exclusion
423 of the skeleton, brain, and extrathoracic airways which could be more effectively modelled as
424 polygon mesh (PM) surfaces.

425 (15) Once provisional organ and tissue models were developed via NURBS and polygon mesh
426 surfaces, the phantom body dimensions were matched to anthropometric data from several
427 literature sources as summarized in Table 3.2 under Step 3. A total of eight reference
428 anthropometric parameters were employed: height (both standing and sitting), length (total arm),
429 biacromial breadth², and circumference (head, neck, waist, and buttock). Of these, *Publication 89*
430 provides reference values for only standing height. Sitting heights for 5-year-old and 10-year-old
431 children, head circumferences for 1-year-old and 5-year-old children, buttock circumferences for
432 5-year-old and 10-year-old children, and biacromial breadths for 5-year-old and 10-year-old
433 children were obtained from the National Health and Nutrition Examination Survey (NHANES)
434 III (1988-1994) data series,³ while other anthropometric data were provided by the database
435 Anthrokids compiled by the U.S. Consumer Product Safety Commission.⁴ Waist circumferences
436 for 5-year-old and 10-year-old children were obtained from the NHANES IV (1999-2002) survey.
437 As a result, only four parameters (standing and sitting height, arm length, and head circumference)
438 were available for the 1-year-old phantoms, and only three parameters (standing and sitting height,
439 and head circumference) were available for the newborn phantom. At each age below 15 years,
440 these same parameters were used for both the male and female phantoms. Once body dimensions
441 were matched to standard anthropometric data, the organ and tissue volumes were adjusted to
442 match reference organ masses provided in *Publication 89* (ICRP, 2002) to within a tolerance of
443 1% under Step 4. Targeted organ volumes were taken as ratios of the reference mass and reference
444 tissue densities were taken from *ICRU Report 46* (ICRU, 1992).

445 (16) Reference lengths and masses for the walls of the alimentary tract organs (esophagus, small
446 intestine, right, left, and rectosigmoid colon) are available from *Publication 89* and *Publication*
447 *100*, whereas reference wall thickness is not reported. As stated in the Section 6.3.10 of *Publication*
448 *89*, the reference lengths are physiological lengths representing those measured in a living person.
449 The values are usually less than corresponding anatomical lengths measured at autopsy or during
450 surgical tissue removal. In this study, the lengths of the alimentary tract organs were matched to
451 their ICRP reference values to within a tolerance of 5% by adjusting the lengths of central trace of
452 each segment, which in turn were obtained from the original patient CT images. Second, a NURBS
453 pipe model with an appropriate radius was generated along these central tracks via a trial and error
454 process until a realistic shape and curvature was obtained. The alimentary tract wall masses were
455 then matched to the reference masses given in *Publication 89* to within a tolerance of 1%.

456 (17) The skin thicknesses (epidermis plus dermis) were derived from three different reference
457 parameters: (1) skin mass and (2) body surface area provided in the Sections 2.3.1 and 10.4 of
458 *Publication 89*, respectively, and (3) a reference skin density from *ICRU Report 46*. Reference

² Distance between the lateral ends (acromion processes) of the left and right scapulae.

³ <http://www.cdc.gov/nchs/nhanes.htm>

⁴ <http://www.itl.nist.gov/div894/ovrt/projects/anthrokids>

459 skin volumes were first calculated from reference skin masses and tissue densities. Next, a derived
460 skin thickness was taken as the ratio of the reference skin volume and associated surface area. This
461 approach, however, yielded a sharp discontinuity in skin thicknesses between the 10-year-old and
462 15-year-old phantoms. In the original pulsed ultrasound study by Tan et al (1982) cited in
463 *Publication 89*, however, these authors concluded that ‘skin thickness was found to increase
464 linearly with age up to the age of 20 years.’ Consequently, adjustments were made to these derived
465 thicknesses at ages 5-year-old and 10-year-old to provide for a more continuous change in skin
466 thickness with increasing phantom age.

467 **3.4. Skeletal tissue model of the paediatric reference phantom series (Step 6)**

468 (18)The skeletal tissues within the UF/NCI paediatric phantom series originally described by
469 Lee et al. (2010) presented the skeleton as a homogeneous mixture of mineral bone (cortical and
470 trabecular) and marrow tissues (active and inactive). As described in Pafundi et al. (in preparation),
471 a further effort was undertaken to develop an age-dependent and bone-specific skeletal tissue
472 model consistent in structure to that of the ICRP adult reference phantoms of *Publication 110*.
473 This step included the creation of additional polygon mesh surfaces to separately define regions of
474 cortical bone, trabecular spongiosa, and the medullary cavities of the long bones.

475 (19)The tissue models were developed using the following criteria. First, the volumes available
476 to assign the various tissue elements were defined by the homogeneous bone volumes present
477 within the constructed age-dependent phantom series which were set at reference heights. Second,
478 the partitioning of mineral bone into cortical bone and trabecular bone was allowed to vary with
479 age based upon the finding by Pafundi et al. (2009) that while cortical bone accounts for 79% of
480 total mineral bone in the 15-year-old, it only accounts for 41% of total mineral bone in the newborn
481 (Pafundi et al., 2009; Pafundi et al., 2010). For each computational phantom, reference values for
482 total mineral bone were targeted, and not those for cortical and trabecular bone separately. As a
483 result, the only the 15-year-old phantoms approached a skeletal average ratio of 80% cortical bone
484 and 20% trabecular bone as given in *Publication 89* for the reference adult. Third, marrow
485 cellularity was assigned to its reference values given in *Publication 70* at each bone site and at
486 each reference age. Reference values for total marrow, and not active and inactive marrow
487 individually, were assigned across the paediatric skeleton at each reference age.

488 (20)Tables 3.3 to 3.8 detail the skeletal tissue models for each of the paediatric reference
489 phantoms. Tissue masses are given for active marrow (AM), inactive marrow (IM), trabecular
490 bone volume (TBV), and cortical bone volume (CBV) both with and without the addition of
491 miscellaneous skeletal tissues (MST). Masses of skeletal endosteum (TM₅₀) are given as well
492 based in part on microCT image analysis as described in Pafundi et al (XXXX).

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494 Table 3.1. CT image sources employed in the development of the UF/NCI paediatric reference phantoms.

Phantom	Head	Torso	C-Vertebrae	Arms and Legs
<i>Newborn M/F</i>			6-day F $0.586 \times 0.586 \times 1 \text{ mm}^3$	
<i>1-Year M/F</i>	2-year F $0.379 \times 0.379 \times 4.5 \text{ mm}^3$	1-year F $0.406 \times 0.406 \times 3 \text{ mm}^3$		
<i>5-Year M/F</i>		4-year F $0.451 \times 0.451 \times 5 \text{ mm}^3$		
<i>10-Year M/F</i>	12-year M $0.469 \times 0.469 \times 6 \text{ mm}^3$	11-year M $0.469 \times 0.469 \times 6 \text{ mm}^3$		
<i>15-Year Male</i>	18-year M ^a 1 mm	14-year M $0.625 \times 0.625 \times 6 \text{ mm}^3$	15-year F $0.21 \times 0.21 \times 0.75 \text{ mm}^3$	18-year M ^c 1 mm
<i>15-Year Female</i>	15-year F $0.449 \times 0.449 \times 4.5 \text{ mm}^3$	14-year F $0.742 \times 0.742 \times 6 \text{ mm}^3$	<i>(all ages except newborn)</i>	<i>(all ages except newborn)</i>

^a Head model of the adult was downscaled to create the 15-year male head model.

^b High resolution (1mm slice thickness) CT images of arms and legs were obtained from an 18-year male cadaver

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498 Table 3.2. Comparison of reference and phantom values (cm) for morphometric parameters regarding body size and shape.

<i>Phantoms</i>	<i>Standing Height</i>			<i>Sitting Height</i>			<i>Arm Length</i>			<i>Biacromial Breadth</i>		
	Ref	Phantom	%Diff	Ref	Phantom	%Diff	Ref	Phantom	%Diff	Ref	Phantom	%Diff
<i>Newborn M/F</i>	51.0	51.0	0.0%	34.0	33.0	-2.9%						
<i>1-Year M/F</i>	76.0	76.0	0.0%	48.8	47.3	-3.1%	32.6	32.0	-1.8%			
<i>5-Year M/F</i>	109.0	109.0	0.0%	60.4	61.0	1.0%	47.1	47.0	-0.2%	25.0	24	-4.0%
<i>10-Year M/F</i>	138.0	138.0	0.0%	73.4	75.2	2.5%	61.0	61.1	0.2%	31.2	30	-3.8%
<i>15-Year M</i>	167.0	167.0	0.0%	88.8	86.5	-2.6%	75.0	75.1	0.1%	38.8	37.2	-4.1%
<i>15-Year F</i>	161.0	161.0	0.0%	85.5	83.0	-2.9%	70.7	71.8	1.6%	36.3	35.4	-2.5%
<i>Phantoms</i>	<i>Head CC</i>			<i>Neck CC</i>			<i>Waist CC</i>			<i>Buttock CC</i>		
	Ref	Phantom	%Diff	Ref	Phantom	%Diff	Ref	Phantom	%Diff	Ref	Phantom	%Diff
<i>Newborn M/F</i>	33.1	32.5	-1.8%									
<i>1-Year M/F</i>	47.3	46.5	-1.7%									
<i>5-Year M/F</i>	51.1	52.0	1.8%	24.9	24.3	-2.4%	55.0	57.0	3.6%	57.9	58.6	1.2%
<i>10-Year M/F</i>	52.8	53.3	0.9%	27.9	27.1	-2.9%	66.7	70.0	4.9%	75.2	73	-2.9%
<i>15-Year M</i>	55.4	55.5	0.2%	32.8	32.2	-1.8%	80.1	83.0	3.6%	92.5	90.5	-2.2%
<i>15-Year F</i>	54.3	56.1	3.3%	30.8	31.0	0.6%	78.8	79.2	0.5%	93.4	93	-0.4%

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501 Table 3.3. Skeletal tissue model for the reference newborn male and female phantoms.

Newborn M/F Skeletal Site	Tissue Masses exclusive of MST (g)				Tissue Masses inclusive of MST (g)					Surface Areas (m ²)			Fractional Tissue Masses & Surface Areas						
	AM	IM	TBV	CBV	AM	IM	TM ₅₀	TBV	CBV	TBS	CBS _{HC}	CBS _{MC}	f _{AM}	f _{IM}	f _{TM50}	f _{TBV}	f _{CBV}	f _{TBS}	f _{CBS}
Craniofacial Bones	12.06	0.00	52.05	18.95	13.55	0.00	11.42	56.06	20.41	0.568	0.034	0.000	0.2412	0.0000	0.3315	0.5170	0.2716	0.5166	0.2679
Mandible	2.17	0.00	2.19	1.50	2.43	0.00	1.48	2.36	1.62	0.024	0.003	0.000	0.0433	0.0000	0.0430	0.0218	0.0216	0.0217	0.0212
Scapulae	1.62	0.00	1.81	2.16	1.82	0.00	1.01	1.95	2.32	0.020	0.004	0.000	0.0324	0.0000	0.0293	0.0180	0.0309	0.0180	0.0305
Clavicles	0.61	0.00	0.68	0.81	0.68	0.00	0.38	0.73	0.87	0.007	0.001	0.000	0.0121	0.0000	0.0110	0.0067	0.0116	0.0067	0.0115
Sternum	0.25	0.00	0.26	0.15	0.29	0.00	0.17	0.28	0.17	0.003	0.000	0.000	0.0052	0.0000	0.0049	0.0026	0.0023	0.0026	0.0021
Ribs	8.14	0.00	8.22	5.65	9.14	0.00	5.55	8.86	6.08	0.090	0.010	0.000	0.1627	0.0000	0.1611	0.0817	0.0809	0.0816	0.0799
Cervical Vertebrae	1.87	0.00	3.87	3.33	2.10	0.00	1.17	4.07	3.58	0.042	0.006	0.000	0.0374	0.0000	0.0340	0.0375	0.0476	0.0384	0.0471
Thoracic Vertebrae	2.58	0.00	5.76	7.55	2.90	0.00	1.58	6.20	8.13	0.063	0.014	0.000	0.0516	0.0000	0.0459	0.0572	0.1082	0.0572	0.1068
Lumbar Vertebrae	2.35	0.00	3.80	2.41	2.64	0.00	1.46	4.09	2.59	0.041	0.004	0.000	0.0470	0.0000	0.0424	0.0377	0.0345	0.0377	0.0341
Sacrum	0.94	0.00	1.52	0.96	1.06	0.00	0.58	1.64	1.04	0.017	0.002	0.000	0.0189	0.0000	0.0168	0.0151	0.0138	0.0151	0.0136
Os coxae	3.15	0.00	3.53	5.43	3.54	0.00	1.97	3.80	5.85	0.039	0.010	0.000	0.0630	0.0000	0.0572	0.0350	0.0778	0.0350	0.0768
Humeri, Upper Half	1.29	0.00	1.71	1.72	1.44	0.00	0.68	1.84	1.84	0.019	0.003	0.000	0.0256	0.0000	0.0197	0.0170	0.0245	0.0170	0.0255
Humeri, Lower Half	1.05	0.00	1.34	1.64	1.18	0.00	0.54	1.45	1.76	0.015	0.003	0.000	0.0210	0.0000	0.0157	0.0134	0.0234	0.0133	0.0244
Radii	0.59	0.00	0.81	1.09	0.66	0.00	0.32	0.87	1.16	0.009	0.002	0.000	0.0118	0.0000	0.0093	0.0080	0.0154	0.0080	0.0163
Ulnae	0.75	0.00	1.05	1.39	0.84	0.00	0.42	1.13	1.50	0.011	0.003	0.000	0.0150	0.0000	0.0122	0.0104	0.0200	0.0104	0.0207
Wrists and Hands	1.21	0.00	1.22	0.74	1.36	0.00	0.83	1.32	0.79	0.013	0.001	0.000	0.0242	0.0000	0.0241	0.0122	0.0105	0.0121	0.0105
Femora, Upper Half	2.24	0.00	2.79	3.32	2.52	0.00	1.10	3.01	3.57	0.030	0.006	0.000	0.0449	0.0000	0.0319	0.0278	0.0475	0.0277	0.0491
Femora, Lower Half	2.25	0.00	2.31	4.85	2.53	0.00	0.93	2.49	5.23	0.025	0.009	0.000	0.0450	0.0000	0.0270	0.0230	0.0696	0.0229	0.0716
Patellae	0.07	0.00	0.07	0.04	0.08	0.00	0.05	0.07	0.04	0.001	0.000	0.000	0.0014	0.0000	0.0015	0.0006	0.0005	0.0007	0.0006
Tibiae	2.45	0.00	3.20	3.96	2.76	0.00	1.26	3.45	4.26	0.035	0.007	0.000	0.0491	0.0000	0.0366	0.0318	0.0567	0.0318	0.0586
Fibulae	0.49	0.00	0.67	1.02	0.55	0.00	0.27	0.72	1.11	0.007	0.002	0.000	0.0098	0.0000	0.0078	0.0066	0.0148	0.0067	0.0154
Ankles and Feet	1.87	0.00	1.89	1.14	2.10	0.00	1.28	2.04	1.23	0.021	0.002	0.000	0.0374	0.0000	0.0372	0.0188	0.0164	0.0188	0.0161
Totals	50	0	101	70	56	0	34	108	75	1.1	0.1	0.0	1.000	0.000	1.000	1.000	1.000	1.000	1.000
			Total Mineral Bone	171			Total Skeletal Mass	240		Total Surface Area	1.2								
ICRP 89 Values	50			170				239											
Ratio	1.00			1.00				1.00											

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505 Table 3.4. Skeletal tissue model for the reference 1-year-old male and female phantoms.

1-Year M/F Skeletal Site	Tissue Masses exclusive of MST (g)				Tissue Masses inclusive of MST (g)					Surface Areas (m ²)			Fractional Tissue Masses & Surface Areas							
	AM	IM	TBV	CBV	AM	IM	TM ₅₀	TBV	CBV	TBS	CBS _{HC}	CBS _{MC}	f _{AM}	f _{IM}	f _{TM50}	f _{TBV}	f _{CBV}	f _{TBS}	f _{CBS}	
Craniofacial Bones	50.46	2.53	198.53	84.38	54.70	2.74	15.25	208.80	88.79	2.153	0.152		0.3274	0.1765	0.2185	0.6173	0.3146	0.6169	0.3119	
Mandible	2.57	0.13	8.61	6.61	2.79	0.14	0.66	9.06	6.95	0.093	0.012		0.0167	0.0090	0.0095	0.0268	0.0246	0.0268	0.0244	
Scapulae	5.22	0.26	7.07	8.90	5.66	0.28	3.79	7.44	9.37	0.077	0.016		0.0339	0.0180	0.0543	0.0220	0.0332	0.0220	0.0329	
Clavicles	0.67	0.03	0.96	1.26	0.73	0.04	0.52	1.01	1.33	0.010	0.002		0.0044	0.0026	0.0074	0.0030	0.0047	0.0030	0.0047	
Sternum	0.84	0.04	0.87	0.58	0.91	0.05	0.42	0.92	0.61	0.009	0.001		0.0054	0.0032	0.0060	0.0027	0.0022	0.0027	0.0021	
Ribs	23.21	1.16	24.38	18.83	25.16	1.26	11.68	25.66	19.81	0.264	0.034		0.1506	0.0812	0.1673	0.0759	0.0702	0.0758	0.0696	
Cervical Vertebrae	4.16	0.21	3.20	3.02	4.51	0.23	1.52	3.37	3.18	0.035	0.005		0.0270	0.0148	0.0218	0.0100	0.0113	0.0099	0.0112	
Thoracic Vertebrae	14.56	0.73	7.89	10.61	15.78	0.79	3.75	8.03	11.16	0.086	0.019		0.0944	0.0509	0.0537	0.0237	0.0395	0.0245	0.0392	
Lumbar Vertebrae	8.08	0.40	10.01	6.52	8.76	0.44	4.75	10.53	6.86	0.109	0.012		0.0524	0.0284	0.0680	0.0311	0.0243	0.0311	0.0241	
Sacrum	5.53	0.28	6.94	5.04	5.99	0.30	4.15	7.30	5.30	0.075	0.009		0.0359	0.0193	0.0594	0.0216	0.0188	0.0216	0.0186	
Os coxae	15.53	0.78	12.34	19.55	16.83	0.84	7.38	12.98	20.57	0.134	0.035		0.1007	0.0541	0.1057	0.0384	0.0729	0.0383	0.0723	
Humeri, Upper Half	2.92	0.12	5.13	11.70	3.16	0.12	1.91	5.40	12.31	0.056	0.021	0.000	0.0189	0.0077	0.0274	0.0160	0.0436	0.0159	0.0442	
Humeri, Lower Half	1.64	0.21	2.69	8.32	1.78	0.22	1.01	2.83	8.75	0.029	0.015	0.000	0.0107	0.0142	0.0145	0.0084	0.0310	0.0084	0.0316	
Radii	0.51	0.06	0.70	5.19	0.54	0.06	0.29	0.74	5.47	0.008	0.009	0.000	0.0032	0.0039	0.0042	0.0022	0.0194	0.0022	0.0199	
Ulnae	0.72	0.08	1.24	6.81	0.79	0.09	0.30	1.30	7.20	0.013	0.012	0.001	0.0047	0.0058	0.0043	0.0038	0.0255	0.0039	0.0262	
Wrists and Hands	2.63	2.50	7.09	4.98	2.85	2.71	2.52	7.46	5.24	0.077	0.009		0.0171	0.1746	0.0361	0.0221	0.0186	0.0220	0.0184	
Femora, Upper Half	3.26	0.12	4.96	13.02	3.54	0.14	2.36	5.21	13.70	0.054	0.024	0.001	0.0212	0.0090	0.0338	0.0154	0.0485	0.0154	0.0492	
Femora, Lower Half	3.77	0.48	4.49	18.95	4.08	0.52	2.15	4.72	19.93	0.049	0.034	0.001	0.0244	0.0335	0.0308	0.0140	0.0706	0.0140	0.0714	
Patellae	0.24	0.03	0.21	0.14	0.26	0.03	0.08	0.22	0.15	0.002	0.000		0.0016	0.0019	0.0011	0.0007	0.0005	0.0007	0.0005	
Tibiae	3.42	0.41	4.16	24.30	3.72	0.44	1.62	4.38	25.56	0.045	0.044	0.001	0.0223	0.0284	0.0232	0.0130	0.0906	0.0129	0.0920	
Fibulae	0.28	0.04	0.34	2.79	0.30	0.04	0.15	0.35	2.93	0.004	0.005	0.000	0.0018	0.0026	0.0021	0.0010	0.0104	0.0011	0.0110	
Ankles and Feet	3.91	3.72	9.99	6.68	4.24	4.04	3.55	10.51	7.03	0.108	0.012		0.0254	0.2603	0.0509	0.0311	0.0249	0.0310	0.0247	
Totals	154	14	322	268	167	16	70	338	282	3.5	0.5	0.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
		Total Mineral Bone						Total Skeletal Mass	803	Total Surface Area			4.0							
ICRP 89 Values	150	20		590				ICRP 89 Value	805											
Ratio	1.03	0.72		1.00				Ratio	1.00											

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507 Table 3.5. Skeletal tissue model for the reference 5-year-old male and female phantoms.

5-Year M/F Skeletal Site	Tissue Masses exclusive of MST (g)				Tissue Masses inclusive of MST (g)					Surface Areas (m ²)			Fractional Tissue Masses & Surface Areas							
	AM	IM	TBV	CBV	AM	IM	TM ₅₀	TBV	CBV	TBS	CBS _{MC}	CBS _{MC}	f _{AM}	f _{IM}	f _{TM50}	f _{TBV}	f _{CBV}	f _{TBS}	f _{CBS}	
Craniofacial Bones	119.85	28.51	294.19	216.19	124.75	29.67	27.67	302.22	222.09	3.115	0.382		0.3254	0.2322	0.2216	0.5428	0.3013	0.5428	0.2983	
Mandible	7.82	1.86	15.31	18.18	8.14	1.94	1.44	15.73	18.68	0.162	0.032		0.0212	0.0152	0.0115	0.0283	0.0253	0.0282	0.0251	
Scapulae	14.81	3.52	17.57	27.64	15.48	3.68	8.22	18.02	28.35	0.186	0.049		0.0404	0.0288	0.0658	0.0324	0.0385	0.0324	0.0381	
Clavicles	2.94	0.74	3.00	5.84	3.07	0.78	1.40	3.07	5.99	0.032	0.010		0.0080	0.0061	0.0112	0.0055	0.0081	0.0055	0.0081	
Sternum	4.12	0.69	2.21	2.33	4.32	0.73	0.88	2.25	2.38	0.023	0.004		0.0113	0.0057	0.0070	0.0040	0.0032	0.0041	0.0032	
Ribs	31.10	5.22	29.70	36.33	32.58	5.47	11.89	30.42	37.21	0.314	0.064		0.0850	0.0428	0.0952	0.0546	0.0505	0.0548	0.0501	
Cervical Vertebrae	5.58	0.94	5.24	6.60	5.84	0.98	2.38	5.37	6.76	0.055	0.012		0.0152	0.0077	0.0191	0.0096	0.0092	0.0097	0.0091	
Thoracic Vertebrae	34.93	5.87	20.95	31.24	36.62	6.15	9.48	21.43	31.95	0.222	0.055		0.0955	0.0481	0.0759	0.0385	0.0433	0.0387	0.0431	
Lumbar Vertebrae	23.40	3.93	21.88	15.85	24.52	4.12	9.91	22.93	16.21	0.232	0.028		0.0640	0.0322	0.0794	0.0412	0.0220	0.0404	0.0219	
Sacrum	15.71	3.97	9.01	11.04	16.47	4.16	4.32	9.21	11.28	0.095	0.019		0.0430	0.0326	0.0346	0.0165	0.0153	0.0166	0.0152	
Os coxae	41.65	10.53	30.79	54.93	43.64	11.04	14.79	31.52	56.25	0.326	0.097		0.1138	0.0864	0.1184	0.0566	0.0763	0.0568	0.0758	
Humeri, Upper Half	8.46	2.29	9.36	27.21	8.79	2.38	3.21	9.61	27.98	0.099	0.048	0.001	0.0229	0.0186	0.0257	0.0173	0.0380	0.0173	0.0384	
Humeri, Lower Half	5.23	2.07	4.99	21.01	5.43	2.15	1.76	5.13	21.60	0.053	0.037	0.001	0.0142	0.0168	0.0141	0.0092	0.0293	0.0092	0.0298	
Radii	2.01	1.44	1.31	14.02	2.07	1.49	0.55	1.35	14.42	0.014	0.025	0.001	0.0054	0.0117	0.0044	0.0024	0.0196	0.0024	0.0203	
Ulnae	2.57	1.83	2.53	17.71	2.64	1.91	0.96	2.60	18.22	0.027	0.031	0.001	0.0069	0.0149	0.0077	0.0047	0.0247	0.0047	0.0254	
Wrists and Hands	1.57	5.97	7.00	8.80	1.64	6.25	2.25	7.17	9.02	0.074	0.016		0.0043	0.0489	0.0180	0.0129	0.0122	0.0129	0.0121	
Femora, Upper Half	13.08	3.64	12.03	46.67	13.58	3.78	4.82	12.36	47.98	0.127	0.082	0.002	0.0354	0.0296	0.0386	0.0222	0.0651	0.0222	0.0662	
Femora, Lower Half	12.16	4.93	12.02	45.34	12.64	5.13	4.70	12.34	46.61	0.127	0.080	0.001	0.0330	0.0401	0.0376	0.0222	0.0632	0.0222	0.0636	
Patellae	2.17	1.56	0.99	1.11	2.28	1.63	0.32	1.01	1.14	0.010	0.002		0.0059	0.0128	0.0026	0.0018	0.0015	0.0018	0.0015	
Tibiae	9.93	7.23	9.58	68.91	10.27	7.37	3.41	9.85	70.91	0.101	0.122	0.003	0.0268	0.0577	0.0273	0.0177	0.0962	0.0177	0.0971	
Fibulae	1.79	1.29	0.89	9.69	1.85	1.33	0.42	0.92	9.96	0.009	0.017	0.001	0.0048	0.0104	0.0034	0.0017	0.0135	0.0016	0.0143	
Ankles and Feet	6.44	24.50	31.47	31.37	6.74	25.66	10.10	32.24	32.14	0.333	0.055		0.0176	0.2008	0.0809	0.0579	0.0436	0.0581	0.0433	
Totals	367	123	542	718	383	128	125	557	737	5.7	1.3	0.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
		Total Mineral Bone					Total Skeletal Mass				Total Surface Area									
ICRP 89 Values	340	160	1260	1260			ICRP 89 Value				1815									
Ratio	1.08	0.77	1.00	1.00			Ratio				0.99									

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509 Table 3.6. Skeletal tissue model for the reference 10-year-old male and female phantoms.

10-Year M/F Skeletal Site	Tissue Masses exclusive of MST (g)				Tissue Masses inclusive of MST (g)					Surface Areas (m ²)			Fractional Tissue Masses & Surface Areas							
	AM	IM	TBV	CBV	AM	IM	TM ₅₀	TBV	CBV	TBS	CBS _{MC}	CBS _{MC}	f _{AM}	f _{IM}	f _{TM50}	f _{TBV}	f _{CBV}	f _{TBS}	f _{CBS}	
Craniofacial Bones	131.87	67.56	224.47	314.11	136.37	69.86	24.56	228.98	320.42	2.309	0.538		0.1753	0.1339	0.1438	0.3557	0.1882	0.3557	0.1866	
Mandible	8.14	4.17	11.17	23.85	8.42	4.32	1.22	11.39	24.33	0.115	0.041		0.0108	0.0083	0.0071	0.0177	0.0143	0.0177	0.0142	
Scapulae	33.73	17.28	26.49	56.75	34.88	17.87	11.00	27.02	57.89	0.272	0.097		0.0448	0.0342	0.0644	0.0420	0.0340	0.0420	0.0337	
Clavicles	6.91	3.86	3.90	13.78	7.14	3.99	1.62	3.98	14.05	0.040	0.024		0.0092	0.0076	0.0095	0.0062	0.0083	0.0062	0.0082	
Sternum	12.21	2.91	2.62	5.06	12.63	3.00	0.89	2.67	5.16	0.027	0.009		0.0162	0.0057	0.0052	0.0041	0.0030	0.0042	0.0030	
Ribs	71.33	16.97	29.52	67.44	73.77	17.55	10.07	30.11	68.79	0.304	0.116		0.0948	0.0336	0.0590	0.0468	0.0404	0.0468	0.0401	
Cervical Vertebrae	15.20	3.61	7.29	13.53	15.71	3.74	3.24	7.44	13.80	0.075	0.023		0.0202	0.0072	0.0190	0.0116	0.0081	0.0116	0.0080	
Thoracic Vertebrae	114.75	27.30	37.61	65.48	118.67	28.23	16.71	38.36	66.80	0.387	0.112		0.1525	0.0541	0.0979	0.0596	0.0392	0.0596	0.0389	
Lumbar Vertebrae	77.90	18.53	40.76	35.19	80.56	19.16	18.11	41.58	35.90	0.419	0.060		0.1035	0.0367	0.1060	0.0646	0.0211	0.0646	0.0209	
Sacrum	29.99	11.10	6.36	15.96	31.01	11.47	2.49	6.49	16.28	0.065	0.027		0.0399	0.0220	0.0146	0.0101	0.0096	0.0101	0.0095	
Os coxae	136.31	50.44	57.99	123.45	140.97	52.16	22.68	59.15	125.93	0.596	0.212		0.1812	0.0999	0.1328	0.0919	0.0740	0.0919	0.0733	
Humeri, Upper Half	22.89	11.76	18.93	84.57	23.67	12.15	6.06	19.31	86.26	0.195	0.145	0.002	0.0304	0.0233	0.0355	0.0300	0.0507	0.0300	0.0510	
Humeri, Lower Half	8.52	14.01	9.26	64.55	8.81	14.50	3.03	9.45	65.80	0.095	0.111	0.002	0.0113	0.0278	0.0177	0.0147	0.0386	0.0147	0.0391	
Radii	2.32	7.39	2.48	42.14	2.40	7.64	0.99	2.54	42.98	0.026	0.072	0.002	0.0031	0.0146	0.0058	0.0039	0.0252	0.0039	0.0258	
Ulnae	2.97	9.45	5.05	54.24	3.07	9.76	1.77	5.16	55.33	0.052	0.093	0.002	0.0039	0.0187	0.0104	0.0080	0.0325	0.0080	0.0331	
Wrists and Hands	0.00	23.00	10.76	31.20	0.00	23.78	3.21	10.98	31.83	0.111	0.053		0.0000	0.0456	0.0188	0.0171	0.0187	0.0171	0.0185	
Femora, Upper Half	37.15	21.37	28.12	157.74	38.41	22.10	9.32	28.68	160.91	0.289	0.270	0.004	0.0494	0.0423	0.0546	0.0446	0.0945	0.0446	0.0952	
Femora, Lower Half	21.31	39.54	33.67	145.70	22.03	40.90	10.68	34.35	148.61	0.346	0.250	0.003	0.0283	0.0784	0.0625	0.0534	0.0873	0.0534	0.0875	
Patellae	2.48	7.90	1.11	2.49	2.57	8.17	0.34	1.13	2.54	0.011	0.004		0.0033	0.0157	0.0020	0.0018	0.0015	0.0018	0.0015	
Tibiae	14.10	44.91	20.63	230.68	14.58	46.44	6.78	21.04	235.31	0.212	0.395	0.006	0.0187	0.0890	0.0397	0.0327	0.1382	0.0327	0.1390	
Fibulae	2.31	7.37	2.04	31.29	2.39	7.62	0.88	2.08	31.92	0.021	0.054	0.003	0.0031	0.0146	0.0052	0.0032	0.0187	0.0032	0.0195	
Ankles and Feet	0.00	94.25	50.75	89.88	0.00	97.47	15.12	51.77	91.68	0.522	0.154		0.0000	0.1868	0.0885	0.0804	0.0538	0.0804	0.0534	
Totals	752	505	631	1669	778	522	171	644	1703	6.5	2.9	0.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
		Total Mineral Bone						Total Skeletal Mass	3646	Total Surface Area										9.4
ICRP 89 Values	630	630	2300	2300				ICRP 89 Value	3650											
Ratio	1.19	0.80	1.00	1.00				Ratio	1.00											

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511 Table 3.7. Skeletal tissue model for the reference 15-year-old male phantom.

15-Year Male Skeletal Site	Tissue Masses exclusive of MST (g)				Tissue Masses inclusive of MST (g)					Surface Areas (m ²)			Fractional Tissue Masses & Surface Areas							
	AM	IM	TBV	CBV	AM	IM	TM ₅₀	TBV	CBV	TBS	CBS _{MC}	CBS _{MC}	f _{AM}	f _{IM}	f _{TM50}	f _{TBV}	f _{CBV}	f _{TBS}	f _{CBS}	
Craniofacial Bones	125.40	97.62	186.93	523.53	129.34	100.84	47.81	190.29	532.93	1.869	0.873		0.1198	0.0652	0.1209	0.2150	0.1646	0.2150	0.1634	
Mandible	10.37	8.08	12.99	57.04	10.70	8.34	3.85	13.22	58.06	0.130	0.095		0.0099	0.0054	0.0097	0.0149	0.0179	0.0149	0.0178	
Scapulae	28.99	22.57	40.71	119.77	29.90	23.31	9.30	41.44	121.92	0.407	0.200		0.0277	0.0151	0.0235	0.0468	0.0377	0.0468	0.0374	
Clavicles	6.85	6.02	4.91	41.66	7.07	6.22	1.72	5.00	42.41	0.049	0.069		0.0066	0.0040	0.0044	0.0056	0.0131	0.0056	0.0130	
Sternum	22.40	7.10	5.38	21.33	23.10	7.34	4.29	5.47	21.72	0.054	0.036		0.0214	0.0047	0.0109	0.0062	0.0067	0.0062	0.0067	
Ribs	99.55	31.57	31.86	162.89	102.67	32.61	18.69	32.43	165.81	0.319	0.271		0.0951	0.0211	0.0473	0.0366	0.0512	0.0366	0.0508	
Cervical Vertebrae	26.33	8.35	11.69	32.48	27.16	8.63	6.36	11.90	33.06	0.117	0.054		0.0252	0.0056	0.0161	0.0134	0.0102	0.0134	0.0101	
Thoracic Vertebrae	130.98	41.54	44.79	87.43	135.09	42.91	27.42	45.60	89.00	0.448	0.146		0.1252	0.0278	0.0694	0.0515	0.0275	0.0515	0.0273	
Lumbar Vertebrae	131.93	41.84	36.47	34.19	136.08	43.22	24.75	37.12	34.80	0.365	0.057		0.1261	0.0280	0.0626	0.0419	0.0107	0.0419	0.0107	
Sacrum	58.50	31.31	9.53	67.06	60.34	32.34	7.14	9.70	68.26	0.095	0.112		0.0559	0.0209	0.0181	0.0110	0.0211	0.0110	0.0209	
Os coxae	230.68	123.46	73.98	181.48	237.92	127.53	53.11	75.31	184.74	0.740	0.302		0.2205	0.0825	0.1343	0.0851	0.0571	0.0851	0.0566	
Humeri, Upper Half	67.78	58.88	35.96	147.32	69.92	60.83	18.51	36.60	149.97	0.360	0.246	0.003	0.0648	0.0394	0.0468	0.0414	0.0463	0.0414	0.0466	
Humeri, Lower Half	3.14	54.08	21.23	161.29	3.24	55.86	8.24	21.61	164.19	0.212	0.269	0.003	0.0030	0.0361	0.0208	0.0244	0.0507	0.0244	0.0510	
Radii	0.00	29.61	10.70	93.89	0.00	30.58	4.57	10.89	95.58	0.107	0.156	0.003	0.0000	0.0198	0.0116	0.0123	0.0295	0.0123	0.0298	
Ulnae	0.00	38.26	17.91	119.75	0.00	39.54	6.96	18.24	121.89	0.179	0.200	0.003	0.0000	0.0256	0.0176	0.0206	0.0376	0.0206	0.0379	
Wrists and Hands	0.00	43.81	11.05	125.69	0.00	45.25	6.48	11.25	127.95	0.111	0.209		0.0000	0.0293	0.0164	0.0127	0.0395	0.0127	0.0392	
Femora, Upper Half	96.58	90.77	66.78	303.13	99.60	93.76	29.93	67.98	308.57	0.668	0.505	0.007	0.0923	0.0607	0.0757	0.0768	0.0953	0.0768	0.0960	
Femora, Lower Half	6.86	185.81	112.88	234.39	7.08	191.94	38.07	114.90	238.61	1.129	0.391	0.006	0.0066	0.1242	0.0963	0.1298	0.0737	0.1298	0.0744	
Patellae	0.00	16.27	4.10	20.62	0.00	16.81	2.41	4.18	20.99	0.041	0.034		0.0000	0.0109	0.0061	0.0047	0.0065	0.0047	0.0064	
Tibiae	0.00	249.36	49.00	366.94	0.00	257.59	29.60	49.88	373.53	0.490	0.612	0.009	0.0000	0.1667	0.0749	0.0564	0.1154	0.0564	0.1163	
Fibulae	0.00	26.98	9.19	69.59	0.00	27.87	4.22	9.36	70.84	0.092	0.116	0.004	0.0000	0.0180	0.0107	0.0106	0.0219	0.0106	0.0224	
Ankles and Feet	0.00	282.98	71.39	209.13	0.00	292.32	41.89	72.67	212.89	0.714	0.349		0.0000	0.1891	0.1060	0.0821	0.0658	0.0821	0.0653	
Totals	1046	1496	869	3181	1079	1546	395	885	3238	8.7	5.3	0.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	
		Total Mineral Bone								Total Surface Area										
				4050					6748			14.0								
ICRP 89 Values	1080			4050					6765											
Ratio	0.97	1.01		1.00					1.00											

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513 Table 3.8. Skeletal tissue model for the reference 15-year-old female phantom.

15-Year Female Skeletal Site	Tissue Masses exclusive of MST (g)				Tissue Masses inclusive of MST (g)					Surface Areas (m ²)			Fractional Tissue Masses & Surface Areas						
	AM	IM	TBV	CBV	AM	IM	TM ₅₀	TBV	CBV	TBS	CBS _{HC}	CBS _{MC}	f _{AM}	f _{IM}	f _{TM50}	f _{TBV}	f _{CBV}	f _{TBS}	f _{CBS}
Craniofacial Bones	101.75	79.21	151.68	434.77	105.00	81.87	37.98	154.45	442.73	1.517	0.725	0.0982	0.0603	0.1078	0.1933	0.1491	0.1933	0.1481	
Mandible	8.10	6.31	10.15	45.60	8.36	6.52	2.95	10.33	46.44	0.102	0.076	0.0078	0.0048	0.0084	0.0129	0.0156	0.0129	0.0155	
Scapulae	39.38	30.66	55.30	166.54	40.64	31.69	12.37	56.32	169.59	0.553	0.278	0.0380	0.0233	0.0351	0.0705	0.0571	0.0705	0.0567	
Clavicles	8.82	7.75	6.32	54.93	9.10	8.01	2.17	6.44	55.94	0.063	0.092	0.0085	0.0059	0.0062	0.0081	0.0188	0.0081	0.0187	
Sternum	15.42	4.89	3.70	15.13	15.92	5.06	2.92	3.77	15.40	0.037	0.025	0.0149	0.0037	0.0083	0.0047	0.0052	0.0047	0.0052	
Ribs	107.27	34.02	34.33	179.86	110.70	35.16	19.92	34.96	183.16	0.343	0.300	0.1036	0.0259	0.0565	0.0438	0.0617	0.0438	0.0613	
Cervical Vertebrae	32.69	10.37	14.51	41.43	33.74	10.72	7.81	14.78	42.19	0.145	0.069	0.0316	0.0079	0.0222	0.0185	0.0142	0.0185	0.0141	
Thoracic Vertebrae	117.23	37.18	40.09	81.11	120.98	38.43	24.27	40.82	82.59	0.401	0.135	0.1132	0.0283	0.0689	0.0511	0.0278	0.0511	0.0276	
Lumbar Vertebrae	143.43	45.49	39.64	39.80	148.02	47.02	26.61	40.37	40.53	0.396	0.066	0.1385	0.0346	0.0755	0.0505	0.0137	0.0505	0.0136	
Sacrum	70.82	37.90	11.54	83.51	73.08	39.17	8.50	11.75	85.03	0.115	0.139	0.0684	0.0288	0.0241	0.0147	0.0286	0.0147	0.0284	
Os coxae	254.75	136.34	81.70	207.58	262.90	140.92	57.67	83.19	211.38	0.817	0.346	0.2460	0.1038	0.1636	0.1041	0.0712	0.1041	0.0707	
Humeri, Upper Half	53.48	46.45	28.38	120.45	55.20	48.02	14.33	28.90	122.65	0.284	0.201	0.003	0.0517	0.0354	0.0407	0.0362	0.0413	0.0362	0.0416
Humeri, Lower Half	2.43	42.24	16.63	129.20	2.51	43.66	6.16	16.93	131.56	0.166	0.215	0.003	0.0023	0.0322	0.0175	0.0212	0.0443	0.0212	0.0446
Radii	0.00	22.87	8.04	81.30	0.00	23.64	3.31	8.19	82.79	0.080	0.136	0.003	0.0000	0.0174	0.0094	0.0103	0.0279	0.0102	0.0282
Ulnae	0.00	29.89	13.78	101.65	0.00	30.90	5.13	14.03	103.52	0.138	0.169	0.003	0.0000	0.0228	0.0146	0.0176	0.0349	0.0176	0.0352
Wrists and Hands	0.00	35.55	8.97	104.46	0.00	36.75	5.01	9.13	106.38	0.090	0.174	0.0000	0.0271	0.0142	0.0114	0.0358	0.0114	0.0356	
Femora, Upper Half	72.70	67.77	50.74	227.88	75.02	70.04	22.30	51.66	232.06	0.507	0.380	0.005	0.0702	0.0516	0.0633	0.0647	0.0782	0.0647	0.0787
Femora, Lower Half	7.30	169.20	99.96	246.09	7.54	174.89	32.18	101.79	250.60	1.000	0.410	0.006	0.0071	0.1288	0.0913	0.1274	0.0844	0.1274	0.0850
Patellae	0.00	13.03	3.29	16.92	0.00	13.47	1.84	3.35	17.23	0.033	0.028	0.0000	0.0099	0.0052	0.0042	0.0058	0.0042	0.0058	
Tibiae	0.00	211.95	42.05	314.11	0.00	219.06	24.24	42.82	319.86	0.421	0.524	0.009	0.0000	0.1613	0.0688	0.0536	0.1077	0.0536	0.1087
Fibulae	0.00	20.44	7.15	52.43	0.00	21.12	3.14	7.28	53.38	0.072	0.087	0.003	0.0000	0.0156	0.0089	0.0091	0.0180	0.0091	0.0185
Ankles and Feet	0.00	224.23	56.57	170.73	0.00	231.77	31.61	57.61	173.85	0.566	0.285	0.0000	0.1707	0.0897	0.0721	0.0586	0.0721	0.0582	
Totals	1036	1314	785	2915	1069	1358	352	799	2969	7.8	4.9	0.0	1.000	1.000	1.000	1.000	1.000	1.000	1.000
		Total Mineral Bone							3700										
ICRP 89 Values	1000			3700					6194										
Ratio	1.04	0.95		1.00					6225			12.7							
									6225										
									1.00										

514

515 3.5. Phantom voxelization (Step 7)

516 (21)At the time of their development, radiation transport codes required that complex
517 anatomical models of the human body be presented in the form of an array of voxelized tissue
518 elements. Resultantly, Step 7 in the development of the ICRP paediatric reference phantoms
519 involved the placement of arrays of tagged tissue voxels within the NURBS/PM surfaces of all
520 internal organs as well as within the surface of the outer body contour. This process – termed
521 ‘voxelization’ – was performed using an in-house routine coded in MATLAB™ as described
522 previously first in Lee et al. (2007) for the newborn phantom , and then later in Lee et al (2010)
523 for the UF/NCI phantom series. Targets for voxel shape (cubic or parallelepiped) were driven by
524 considerations of the age-dependent total reference skin thickness, while the targeted total voxel
525 matrix size was set at approximately 55 million voxels (see Section 4.1 below).

526 3.6. Modifications to the paediatric reference phantom series (Steps 8 and 9)

527 (22)Steps 8 and 9 of phantom development included various modifications to the UF/NCI series
528 of paediatric reference phantoms to ensure conformity to the structure and computational format
529 established in *Publication 110* for the ICRP adult reference computational phantoms. As
530 *Publication 89* was used as guidance for paediatric phantom construction, a significant majority
531 of organs within the *Publication 110* phantoms were already present within the UF/NCI paediatric
532 phantoms. Notable exceptions included tissue structures of the breast, colon, lungs, skin, ureters,
533 and major blood vessels.

534 (23)In the UF/NCI phantoms, the breast was modelled as a homogeneous tissue region, while
535 in the *Publication 110* adult female phantom, the breast included both an adipose and glandular
536 tissue compartment. Accordingly, the breasts of the 15-year-old male and female phantoms were
537 thus remodelled into their glandular and adipose regions. *Publication 89* does not give reference
538 masses for the breasts at ages below 15 years, and thus small tissue regions were placed in these
539 phantoms as described by Lee et al. (2010). The colon of the UF/NCI paediatric phantoms was
540 modelled as the right colon, left colon, and rectosigmoid colon, whereas in *Publication 110*, the
541 adult phantoms were presented with the colon as the ascending colon, transverse colon, descending
542 colon, and rectum. The colon in the UF/NCI series was thus changed to mirror these divisions
543 within the adult reference phantoms. In the UF/NCI phantoms, the lung was modelled as a
544 homogenous structure, while in the reference adult phantom, there exists segmented regions of
545 pulmonary blood vessels. These adult structures of pulmonary blood vessels were thus taken from
546 the adult phantom, proportionally scaled, and then inserted within the lungs of paediatric
547 phantoms. In the UF/NCI phantoms, the skin was treated as a single tagged structure, whereas in
548 the reference adult phantoms, the skin was tagged separately for regions of the head, trunk, arms,
549 and legs. This four-region separation of the skin was thus implemented in the paediatric phantom
550 series. Finally, the ureters were added to paediatric reference phantoms, as they were not present
551 within the UF/NCI phantom series. The development of models for the major blood vessels is
552 described in Wayson (2012).

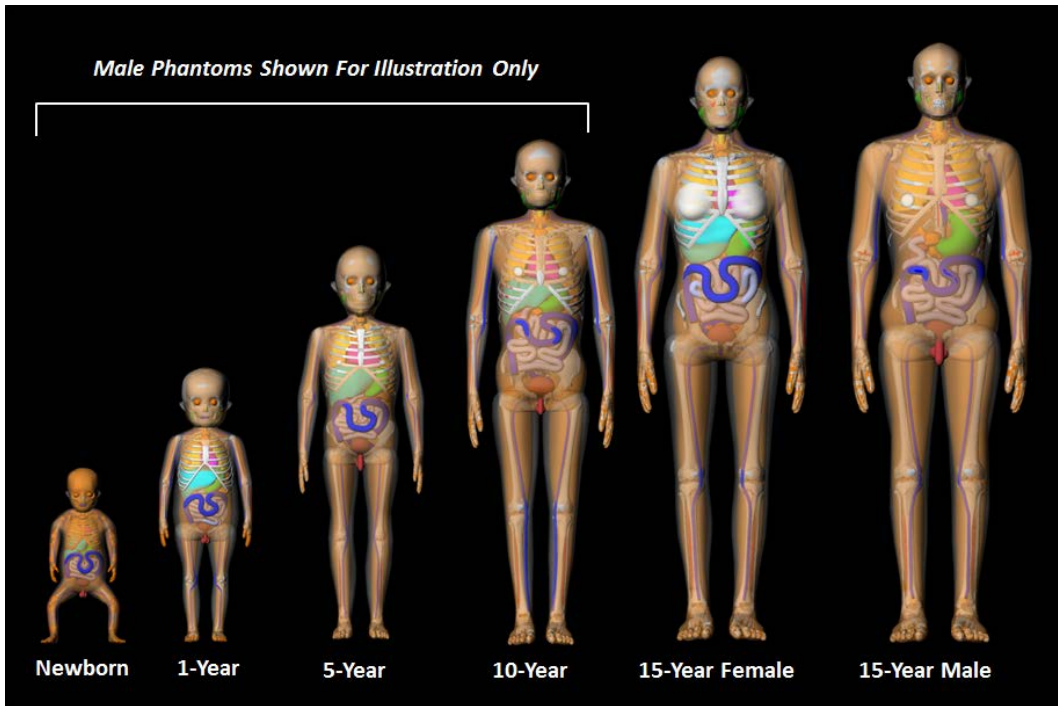
553 (24)Lymphatic nodes were added to the UF/NCI paediatric phantom series following the
554 algorithm of Lee et al. (2013) which defined 16 cluster locations within each phantom:

555 extrathoracic, cervical, thoracic (upper and lower), breast (left and right), mesentery (left and
556 right), axillary (left and right), cubital (left and right), inguinal (left and right), and popliteal (left
557 and right). Reference values of lymphatic node number and node size were derived from
558 information given in both *Publication 23* and *89* (ICRP, 1975, 2002). Lymphatic nodes generated
559 by the Lee et al. (XXXX) algorithm were applied post-voxelization via a voxel tagging approach.

560 (25) In the original design of the UF/NCI paediatric phantoms, a residual soft tissue region was
561 defined as a homogeneous mixture between adipose tissue and skeletal muscle in a manner similar
562 to that of the ORNL stylised phantoms. With the adoption of the UF/NCI phantoms by ICRP, a
563 separation of skeletal muscle and subcutaneous / intra-abdominal fat was required. For this
564 purpose, a voxel growing algorithm was introduced to appropriate bones of the skeleton. The final
565 models were reviewed for anatomic accuracy in comparison to equivalent cross-sectional images
566 of the *Publication 110* phantoms in which skeletal muscle was segmented directly from the
567 original CT image sets. The procedure for the revised skeletal muscle model is described in
568 Stepusin (2016).

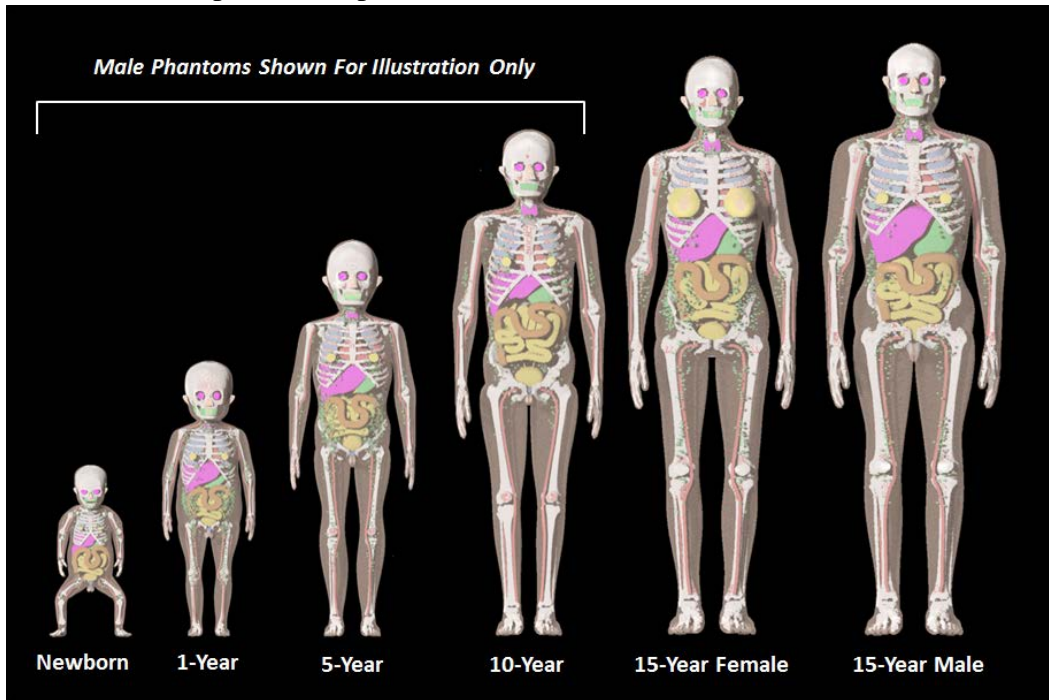
569 (26) Visual representations of the reference paediatric phantoms are shown in Figures 3.1 and
570 3.2 below. Figure 3.1 shows frontal images of the UF/NCI paediatric reference phantoms in their
571 original NURBS/PM format prior to Step 7 voxelization. For phantom below the age of 15-years,
572 only the male phantoms are shown. The female phantoms at this age have identical body size and
573 internal anatomy, with the obvious exception of the sex organs. Figure 3.2 shows frontal views of
574 the final ICRP paediatric reference phantoms in their voxelized format. Again, for ages below 15-
575 years, only the male phantoms are shown, while there exists 10 paediatric reference phantoms in
576 total.
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580 Fig. 3.1. UF/NCI series of reference paediatric computational phantoms in their NURBS and
581 polygon mesh formats (prior to Step 7 voxelization).



582

583 Fig. 3.2. ICRP series of reference paediatric voxel-based computational phantoms (following Step
584 7 voxelization and Steps 8 and 9 modification).

585
586

4. DESCRIPTION OF THE ICRP PAEDIATRIC REFERENCE PHANTOMS

4.1. Main characteristics of the paediatric phantoms

588 (27)The orientation of the three-dimensional voxel array (arranged in columns, rows, and
589 slices) describing each member of the paediatric computational phantom series is as follows. The
590 columns correspond to the x-coordinates, the rows correspond to the y-coordinates, and the slices
591 correspond to the z-coordinates. Column numbers increase from right to left, row numbers increase
592 from front to back, and slice numbers increase from the toes to the vertex of the body. This
593 convention is equivalent to that established in *Publication 110* for the reference adult
594 computational phantoms.

595 (28)The main characteristics of the paediatric reference computational phantoms are given in
596 Table 4.1 which summarises the final voxel resolution, voxel count, and total matrix size of each
597 of the reference paediatric phantoms, along with these same parameters for the adult reference
598 phantoms of *Publication 110*. A goal of the paediatric phantom series was to limit the total matrix
599 size to approximately 55 million voxels, while maintaining the in-plane voxel size to roughly the
600 reference skin thickness at each phantom age. For the newborn reference phantoms (both male and
601 female), isotropic voxels of 0.663 mm on edge were employed. For the remaining phantoms, the
602 in-plane resolution was again set at the reference total skin thickness, allowing the z-dimension of
603 the voxels to vary while maintaining the imposed limit on the total matrix size. The higher
604 resolution of the paediatric phantoms, owing to their method of construction, is evident in
605 comparison to the total matrix sizes of the *Publication 110* adult phantoms – 7.16 and 14.26 million
606 voxels for the adult male and adult female, respectively.

607 (29)Table 4.2 shows a list of the source and target regions of the series of 10 paediatric reference
608 phantoms, their segmented volumes, and resulting tissue masses. For comparison, ICRP reference
609 masses are also shown.

610

611

Table 4.1. Main characteristics of the reference paediatric computational phantoms.

Property	Newborn M/F	1-Year M/F	5-Year M/F	10-Year M/F	15-Year M	15-Year F	Adult Male (P110)	Adult Female (P110)
Height (cm)	51*	76	109	138	167	161	176	163
Mass (kg)	3.5	10	19	32	56	53	73	60
Number of total voxels (matrix size)	52,121,220	53,215,344	55,123,640	54,543,744	53,662,950	54,037,156	7,161,276	14,255,124
Number of tissue voxels (less non-void voxels)	11,674,368 / 11,673,990	16,250,953 / 16,248,983	13,502,240 / 13,502,124	13,257,717 / 13,256,857	12,605,741	13,061,008	1,946,375	3,886,020
Slice thickness (voxel height, mm)	0.663	1.400	1.928	2.425	2.832	2.828	8.000	4.84
Voxel in-plane resolution (mm)	0.663	0.663	0.850	0.990	1.250	1.200	2.137	1.775
Voxel volume (mm ³)	0.291	0.615	1.393	2.377	4.425	4.072	36.534	15.249
Number of columns	345	393	419	419	407	401	254	299
Number of rows	211	248	230	226	225	236	127	137
Number of slices	716	546	572	576	586	571	222	348

* The newborn phantoms have legs that are bent, and thus the "height" is more appropriately the phantom "length"

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615 Table 4.2. List of source and target regions, their segmented volumes, and resulting masses compared with the reference masses of
 616 Publication 89.

Organ	Newborn M/F			1-Year M/F			5-Year M/F			10-Year M/F			15-Year Male			15-Year Female		
	Volume (cm ³)	Mass (g)	Reference mass (g)	Volume (cm ³)	Mass (g)	Reference mass (g)	Volume (cm ³)	Mass (g)	Reference mass (g)	Volume (cm ³)	Mass (g)	Reference mass (g)	Volume (cm ³)	Mass (g)	Reference mass (g)	Volume (cm ³)	Mass (g)	Reference mass (g)
Adrenals	5.8	6.0	6	3.9	4.0	4	4.8	5.0	5	6.8	7.0	7	9.7	10.0	10	8.8	9.0	9
Blood (segmented vessels)*	11.1	11.7	290	23.9	25.3	530	62.1	65.8	1500	131.7	139.6	2500	246.9	261.7	4800	225.0	238.5	3500
Brain	307.5	316.7	380	922.0	949.7	950	1196.8	1244.7	1245	1258.9	1309.2	1310	1364.6	1419.2	1420	1246.2	1296.0	1300
Breast	0.3	0.3		2.1	2.1		4.9	4.8		7.9	7.8		15.4	14.9	15	251.6	250.6	250
Eyes	5.9	6.2	6	7.0	7.3	7	11.0	11.5	11	12.0	12.6	12	13.1	13.8	13	13.0	13.7	13
Eye lenses	0.1	0.1		0.2	0.2		0.3	0.3		0.3	0.3		0.4	0.5		0.4	0.4	
Gall bladder	3.2	3.3	3.3	9.1	9.4	9.4	17.1	17.6	17.6	29.4	30.3	30.4	51.0	52.6	52.7	48.3	49.3	49.3
Gall bladder wall	0.5	0.5	0.5	1.4	1.4	1.4	2.5	2.6	2.6	4.2	4.4	4.4	7.5	7.7	7.7	7.1	7.2	7.3
Gall bladder content	2.7	2.8	2.8	7.8	8.0	8	14.5	15.0	15	25.2	25.9	26	43.5	44.8	45	41.2	42.1	42
Gastrointestinal tract																		
Stomach wall	6.8	7.0	7	19.3	19.9	20	48.6 / 48.55	50.0	50	82.4	84.9 / 84.8	85	116.1	119.6	120	116.0	119.5	120
Stomach contents	24.6	25.3	40	65.2	67.2	67	80.3	82.7	83	113.5	117.0 / 116.9	117	192.9	198.6	200	196.0	199.9	200
Small intestine wall	28.9	29.8	30	82.1 / 81.9	84.6 / 84.4	85	212.2 / 211.9	218.5 / 218.3	220	358.5 / 358.7	369.3 / 369.4	370	501.3	516.3	520	506.4	521.6	520
Small intestine contents	30.7 / 30.8	31.6 / 31.7	56	46.8 / 46.9	48.2 / 48.3	93	35.5 / 35.8	36.6 / 36.9	117	288.0 / 287.1	163.0	163	656.8	280.0	280	614.7	280.0	280
Right colon wall	6.8	7.0	7	19.3	19.9	20	47.3 / 47.4	48.7 / 48.8	49	81.1 / 81.9	83.6 / 84.3	85	118.2	121.7	122	118.0	121.6	122
Right colon contents	15.2	15.6	24	15.0	15.4	40	26.3	27.0 / 27.1	50	27.2	28.0	70	70.1	72.2	120	42.9	43.7	120
Left colon wall	6.8	7.0	7	19.3 / 19.4	19.9	20	47.1 / 47.2	48.6	49	82.0	84.4	85	117.9	121.4	122	117.7	121.3	122
Left colon contents	18.4	12.0	12	20.9	19.9	20	32.7	24.9	25	33.7	16.5	35	84.7	28.8	60	60.8	59.6	60
Rectosigmoid colon wall	2.9	3.0	3	9.7	10.0	10	21.4	22.0	22	38.9	40.1	40	53.9	55.5	56	54.7	56.3	56
Rectosigmoid colon contents	9.4	9.6	12	14.1	14.6	20	28.9	25.0	25	31.1	32.0	35	80.2	60.0	60	51.2	52.2	60
Heart																		
Heart wall	19.1	19.9	20	48.2	50.1	50	81.4	84.7	85	133.8	139.2	140	221.1	230.0	230	211.7	220.2	220
Heart contents (blood)	5.7	6.0	26	45.2	47.9	48	127.2	134.8	135	216.3	229.3	230	404.4	428.7	430	300.8	318.9	320
Kidneys	25.5	26.3	25	70.6	73.4	70	111.0	115.4	110	181.5	188.7	180	252.5	262.6	250	242.3	251.9	240
Liver	124.7	129.7	130	313.8	329.5	330	542.1	569.2	570	788.9	828.3 / 828.4	830	1236.6	1298.4	1300	1237.6	1299.4	1300
Lungs	97.1	60.0	60	375.1	150.0	150	748.4	300.0	300	1166.5 / 1166.4	500.0	500	2614.7	900.0	900	2494.7	750.0	750
Lymphatic tissue †	13.8 / 13.9	14.2 / 14.3		24.3	25.1 / 25.0		47.5 / 47.2	48.9 / 48.6		78.3 / 79.0	80.7 / 81.4		138.4	142.5		127.4	129.9	
Muscle tissue	762.2 / 762.1	800.3 / 800.2	800	1809.5	1900.0	1900	5333.3	5600.0	5600	10476.2	11000.0	11000	22857.3	24000.1	24000	16190.3	16999.8	17000
Oesophagus	1.9	2.0	2	4.9	5.0	5	9.6 / 9.7	9.9 / 10.0	10	17.4 / 17.5	18.0	18	28.9	29.7	30	28.9	29.8	30
Ovaries	0.3	0.3	0.3	0.8	0.8	0.8	1.9	2.0	2	3.3	3.5	3.5	5.7	5.7	6	6.0	6.0	6
Pancreas	5.8	6.0	6	19.4	19.9	20	33.9	34.9	35	58.0	59.7	60	106.6	109.8	110	97.9	99.9	100
Pituitary gland	0.1	0.1	0.1	0.1	0.2	0.15	0.2	0.3	0.25	0.3	0.4	0.35	0.5	0.5	0.5	0.5	0.5	0.5
Prostate gland	0.8	0.8	0.8	1.0	1.0	1	1.2	1.2	1.2	1.6	1.6	1.6	4.2	4.3	4.3	4.3	4.3	4.3
Residual (adipose) tissue	1408.6 / 1406.5	1394.6 / 1392.4	930	5037.1 / 5038.0	4835.7 / 4836.5	3800	7736.7 / 7736.1	7427.3 / 7426.6	5500	11693.3 / 11689.0	11225.6 / 11221.4	8600	16468.5	15809.7	12000	21666.7	20800.0	18700
Salivary glands	5.8	6.0	6	23.3	24.0	24	32.9	33.9	34	42.5	43.8	44	66.5	67.8	68	63.4	65.3	65
Skin	106.7 / 106.1	117.4 / 116.7	175	230.5 / 229.6	253.6 / 252.5	350	521.0 / 519.7	573.1 / 571.7	570	890.9 / 889.0	980.0 / 978.0	820	1685.2	1853.7	2000	1524.7	1677.2	1700
Skeleton	298.8	385.8	369.3	890.6	1163.4	1165	1821.7	2404.9	2415	3392.6	4467.1	4470	5979.5	7887.6	7905	5378.7	7114.3	7145
Cortical bone ‡	47.3	78.1	135	151.6	268.2	470	422.4	718.0	1010	953.8	1669.1	1840	1767.0	3180.6	3240	1619.7	2915.5	2960
Trabecular bone §	65.3	107.8	35	193.9	321.8	120	318.8	542.0	250	360.6	631.0	460	483.0	869.4	810	435.8	784.5	740
Cartilage ¶	118.2	130.0	130	327.3	360.0	360	545.5	600.0	600	745.5	820.0	820	1036.4	1140.0	1140	836.4	920.0	920
Active marrow §	48.5	50.0	50	149.6	154.1	150	356.6	367.3	340	730.5	752.4	630	1015.9	1046.3	1080	1005.4	1035.6	1000
Inactive marrow ¶				14.6	14.3	20	125.0	122.5	160	515.0	504.7	630	1526.8	1496.3	1480	1340.6	1313.7	1380
Miscellaneous tissues §	19.4	20.0	20	43.7	45.0	45	53.4	55.0	55	87.4	90.0	90	150.5	155.0	155	140.8	145.0	145
Spleen	9.1	9.5	9.5	27.3	29.0	29	47.1	49.9	50	75.1	79.6	80	122.2	129.6	130	121.9	129.2	130
Teeth			0.7			5		9.0	14.9	15		12.8	29.8	30		45.0	45	
Testes	0.8	0.8	0.85	1.4	1.5	1.5	1.6	1.7	1.7	1.9	2.0	2	15.4	16.0	16	15.4	16.0	16
Thymus	12.1	12.9	13	15.6	16.1	30	29.2	30.1	30	36.2	37.3	37.5	34.1	35.1	35	29.0	29.9	30
Thyroid	1.2	1.3	1.3	1.7	1.8	1.8	3.2	3.4	3.4	7.5	7.9	7.9	11.4	12.0	12	11.4	12.0	12
Tongue	4.1	4.3	3.5	10.1	10.5	10	19.2	20.1	19	31.3	32.9	32	57.8	60.6	56	57.9	60.6	53
Tonsils	0.1	0.1	0.1	0.5	0.5	0.5	1.9	2.0	2	2.9	3.0	3	2.9	3.0	3	2.9	3.0	3
Ureters	0.3	0.4	0.77	0.6	0.6	2.2	1.8	1.8	4.2	2.6	2.7	7	4.5	4.6	12	5.1	5.2	12
Urinary bladder																		
Urinary bladder wall	3.8	4.0	4	8.7	9.0	9	15.4 / 15.3	16.0 / 15.9	16	24.0 / 23.9	25.0 / 24.9	25	38.3	39.8	40	33.5	34.9	35
Urinary bladder contents	9.9	10.0		10.9 / 10.0	11.0 / 10.1		61.1	61.7		97.5 / 97.4	98.4		151.8	153.3		132.8	134.1	
Uterus	3.8	4.0	4	1.4	1.5	1.5	2.9	3.0	3	3.8	4.0	4				28.5	29.9	30
Total Body	3400	3500	3500	10000	10000	10000	18800	19000	19000	31500	32000	32000	55800	56000	56000	53200	53000	53000

Some of the reference values (e.g., blood and lymphatic tissue) duplicates other mass information and are, thus, not additive.

* Segmented blood vessels versus total blood (partly included in the organ).

† Segmented lymph nodes versus "fixed" lymphatic tissue including lymphatic ducts and lymph

‡ Segmented directly

§ Incorporated in spongiosa regions

¶ Partly segmented directly and partly incorporated in spongiosa regions.

617

618

619 4.2. The skeletal source regions

620 (30)For internal sources in the skeleton, the following source regions have to be considered:
621 cortical bone (surface or volume), trabecular bone (surface or volume), and cortical and trabecular
622 bone marrow. As discussed in *Publication 110*, no distinction is made between surface and volume
623 sources in the cortical and trabecular regions of the computational phantoms. The results from the
624 respective volume sources are to be applied to estimate values for the bone surface sources when
625 using the computational reference phantoms for radiation transport simulations. A cortical bone
626 volume has been defined separately in all bones and bone groups of the skeleton, and thus the
627 entirety of these voxels can be directly used to sample a uniform source distribution.

628 (31)As described previously, trabecular bone is one of the constituents that make up the
629 spongiosa. Therefore, the entirety of the spongiosa voxels of all bones serve as the volume which
630 can be sampled for particle emission. However, since the relative amount of trabecular bone in the
631 spongiosa varies between individual bones and bone groups, and across the age-dependent
632 phantom series, the source should not simply be assumed to be homogeneously distributed. For
633 Monte Carlo radiation transport calculations, the variation of trabecular bone mass fraction should
634 be used, e.g., either to determine the probability of a start position being selected, or to assign
635 bone-specific initial statistical weights to the particles starting in the spongiosa volumes of the
636 various regions of the skeleton. Fractional tissue masses and bone surface areas provided in Tables
637 3.3 to 3.8 may be used for this purpose.

638 (32)For cortical marrow, medullary cavities have been defined in the shafts of the long bones,
639 so the entirety of these segmented voxels can be directly used to sample a uniform source
640 distribution. While in the adult models of *Publication 110* the medullary cavities contain only
641 inactive (yellow) marrow, the marrow cellularities vary with reference age and long bone site as
642 given in *Publication 70*.

643 (33)The trabecular marrow is the marrow situated in the spongiosa regions of the skeleton.
644 Consequently, the same particle source sampling principle as for the trabecular bone should be
645 applied for the trabecular marrow, now considering the bone-specific relative bone marrow content
646 (active and inactive marrow). The fractional tissue masses of Tables 3.3 to 3.8 may be used for
647 this purpose.

648 4.3. The skeletal target regions

649 (34)The skeletal target tissues of interest are the active (red) bone marrow and the endosteal
650 tissues (formerly called bone surfaces). Since the dimensions of the marrow cavities and the
651 endosteal layer lining these cavities (assumed to be of thickness 50 μm) are clearly finer than the
652 resolution of the voxelized computational phantoms, they cannot be directly represented, and have
653 to be considered in the homogeneous tissues of the spongiosa volumes. However, in contrast to
654 the source volumes described above, it is not sufficient to consider the bone-specific relative
655 amounts of these tissues in the spongiosa. The reason is that for photon and neutron irradiation of
656 the skeleton, secondary particle disequilibria may exist. For photons, these typically take the form
657 of a dose enhancement with photoelectron interactions favouring interaction sites in bone
658 trabeculae. For neutrons, these typically take the form of a dose suppression with the hydrogen

659 elastic scattering favouring interactions sites in the marrow tissues. Specific techniques for
660 assessing photon and neutron dose in the skeletal tissues of the reference adults are reviewed in
661 the Annexes E and F of *Publication 116*, respectively. Techniques for application to the reference
662 paediatric phantoms have been developed and will be reported in a forthcoming ICRP Publication.

663 **4.4. Model of regional blood distribution**

664 (35)As was the case for the adult reference phantoms of *Publication 110*, it is not possible to
665 fully represent the entire blood pool of the body within the voxelized structures of the paediatric
666 reference computational phantoms. As described in Wayson (2012), an attempt was made to place
667 NURBS tubular structures within the paediatric phantom series to represent the major blood
668 vessels of the body. No attempt was made to segment the blood vessels in the original CT images
669 during initial phantom construction due to image resolution limitations. A significant portion of
670 the total body blood volume is thus situated in the smaller vessels and capillaries within most
671 organs and tissues, and these vascular structures are not modelled explicitly in the paediatric
672 reference phantom series. As noted in *Publication 110*, organ elemental compositions given in
673 *Publication 89* (ICRP, 2002) and in *ICRU Report 46* (ICRU, 1992) are exclusive of organ blood
674 content, and thus are relevant only to organ parenchyma.

675 (36)In this report, we have followed the methodology of Section 5.3 in *Publication 110* in
676 which the elemental compositions of the organs and tissues of the paediatric reference
677 computational phantoms have been computed as a homogeneous mixture of the elemental
678 compositions of the organ parenchyma and their intra-organ blood content. To accomplish this
679 step, values of the fractional distribution of total blood amongst the organs and tissues of the body
680 need to be assigned. *Publication 89*, however, provides this data for only the reference adults. In
681 work described in Wayson (2012), we have derived age-dependent values of the regional blood
682 distribution as shown in Table 4.3. These values were derived via organ volume proportional
683 scaling of the adult values (male and female computed separately), with additional consideration
684 of age-dependent vascular growth in the brain, kidneys, and skeletal tissues. Final values of the
685 phantom-specific and tissue-specific elemental compositions are given in Annex B of this report.
686

687 Table 4.3. Values for regional blood distribution (% total blood volume) for the ICRP reference
 688 individuals adopted in this report and as described in Wayson (2012).

Organ or Tissue	Newborn		1-Year-Old		5-Year-Old		10-Year-Old		15-Year-Old		Adult	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Fat	5.73	5.78	9.32	9.47	5.94	6.04	5.35	5.43	3.90	7.68	5.00	8.50
Brain	6.42	5.57	6.97	6.09	5.31	4.18	3.25	2.47	1.59	1.47	1.20	1.20
Stomach & Esophagus Wall	0.92	0.78	1.00	0.85	1.10	0.94	1.13	0.96	0.95	0.93	1.00	1.00
Small Intestine Wall	3.41	2.88	3.77	3.20	4.48	3.80	4.53	3.83	3.65	3.57	3.80	3.80
Large Intestine Wall	1.97	1.57	2.26	1.82	2.48	2.00	2.61	2.10	2.14	1.99	2.20	2.20
Right Heart Contents	4.42	4.74	3.21	3.47	4.15	4.48	4.25	4.57	4.56	4.22	4.5	4.50
Left Heart Contents	4.42	4.74	3.21	3.47	4.15	4.48	4.25	4.57	4.56	4.22	4.5	4.50
Coronary Tissues	1.19	1.22	1.16	1.20	0.91	0.94	0.90	0.92	0.85	0.96	1.00	1.00
Kidneys	2.13	1.87	2.31	2.04	2.49	2.20	2.45	2.16	1.96	1.91	2.00	2.00
Liver	14.31	14.33	14.04	14.14	11.13	11.21	9.74	9.79	8.76	10.16	10.00	10.00
Pulmonary Tissues	5.52	5.59	8.22	8.37	7.73	7.89	9.15	9.31	9.76	9.85	10.50	10.50
Bronchial Tissues	1.06	1.04	1.58	1.56	1.51	1.50	1.73	1.72	1.85	1.88	2.00	2.00
Skeletal Muscle	7.58	7.33	7.03	6.84	9.50	9.25	11.22	10.90	14.06	11.16	14.00	10.50
Pancreas	0.50	0.45	0.65	0.59	0.52	0.47	0.54	0.49	0.57	0.54	0.60	0.60
Skeletal Tissues												
Active Marrow	3.32	3.36	3.89	3.96	4.05	4.12	4.51	4.58	4.44	4.82	4.00	4.00
Trabecular Bone	4.02	4.30	5.34	5.75	4.67	5.03	4.56	4.90	4.15	4.70	1.20	1.20
Cortical Bone	1.43	1.53	1.93	2.08	1.72	1.85	1.67	1.80	1.42	1.61	0.80	0.80
Miscellaneous Skeletal Tissues	0.61	0.64	0.68	0.71	0.63	0.66	0.79	0.82	0.85	0.92	1.00	1.00
Skin	3.09	3.46	2.41	2.71	1.80	2.03	1.56	1.75	2.19	2.40	3.00	3.00
Spleen	1.76	1.58	2.05	1.86	1.62	1.47	1.56	1.41	1.46	1.52	1.40	1.40
Thyroid	0.08	0.07	0.04	0.04	0.04	0.03	0.05	0.05	0.04	0.05	0.06	0.06
Lymphatic Nodes	0.19	0.17	0.21	0.20	0.18	0.17	0.18	0.17	0.18	0.19	0.20	0.20
Testes or Ovaries	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.01	0.02	0.01	0.04	0.02
Adrenal Glands	0.50	0.42	0.13	0.11	0.07	0.06	0.06	0.05	0.05	0.05	0.06	0.06
Urinary Bladder Wall	0.03	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
All Other Tissues	1.50	1.30	1.38	1.15	1.48	1.41	1.59	1.49	1.38	1.14	1.92	1.94
Aorta and Large Arteries	5.97	6.31	4.29	4.57	5.58	5.94	5.59	5.93	6.16	5.51	6.00	6.00
Large Veins	17.90	18.93	12.88	13.71	16.73	17.82	16.76	17.80	18.48	16.52	18.00	18.00
	100	100	100	100	100	100	100	100	100	100	100	100

689

690 **4.5. Phantom Limitations**

691 (37)As with the adult reference computational phantoms of *Publication 110*, there also exist
 692 limitations of the paediatric phantom series of this report due to their voxelized nature. As
 693 described in Section 5.4 of *Publication 110*, the major of the limitations in the adult reference
 694 phantoms were attributed to the corresponding limitations in CT image resolution from which the
 695 phantoms were constructed. As outlined in Figure 3.1 of this report, however, the revised process
 696 of NURB/PM surface modelling and subsequent voxelization of the paediatric reference phantoms
 697 allowed for significant improvements in matching phantom organ mass to their reference values,
 698 over that seen in the adult phantoms. Notable exceptions, as outlined in Lee et al. (2010), included
 699 an underestimate on the reference content masses of the GI tract organs: stomach contents in the
 700 newborn phantoms, small intestine contents in the newborn, 1-year-old, and 5-year-old phantoms,
 701 and colon contents in the full series of paediatric phantoms. Reference values of GI tract organ
 702 wall masses and lengths, were however persevered to within a few percent of reference values.
 703 Other limitations are noted in an underestimate of the heart contents of the newborn phantoms,
 704 and the urinary bladder contents in the newborn and 1-year-old phantoms. Skin masses are also
 705 not in compliance with their reference values, in which reference total skin masses of the newborn
 706 and 1-year-old phantoms are underestimated, while they are overestimated in the 5-year-old, 10-
 707 year-old, and 15-year-old phantoms. As described in Lee et al. (2010), the original design of the
 708 phantoms did not permit simultaneous matching of both reference skin mass and reference skin
 709 thickness. The latter was deemed more appropriate, particularly for applications of external
 710 dosimetry, and was thus given deference in the phantom design. Finally, as with the adult reference
 711 phantoms, the microscopic target regions of the skeleton, respiratory tract, and alimentary tract
 712 organs (including their stem cell targets) are not modelled in the voxelized structures of the

713 paediatric reference phantom series. As such, supplemental models of these tissue regions as given
714 in Pafundi et al. (in preparation), *Publication 66* (ICRP, 1994), and *Publication 100* (ICRP, 2006)
715 continue to be applied for computation of specific absorbed fractions for internal exposures.
716

717
718

5. APPLICATIONS AND LIMITATIONS OF THE PAEDIATRIC REFERENCE PHANTOMS

719 (38)The phantoms presented in this document are the official computational models
720 representing the ten-member paediatric series of reference individuals – male and female at
721 newborn, 1-year-old, 5-year-old, 10-year-old, and 15-year-old. These reference computational
722 models are based on computed tomographic data of real individuals and hence represent digital
723 three-dimensional representations of human anatomy. They are defined to enable calculations of
724 the protection quantities – organ and tissue equivalent dose, and effective dose – from exposure to
725 ionising radiations. ICRP will publish recommended values of dose coefficients for both external
726 and internal environmental exposures using these series of paediatric reference phantoms. These
727 documents will include specific absorbed fractions for particles relevant to internal exposures, and
728 dose coefficients for externally incident environmental radiation fields.

729 (39)It should be clear that although these phantoms have organ masses of reference values, they
730 still have individual organ topology (organ shape, depth, and position) reflecting the tomographic
731 data used in their construction. Resultantly, these models cannot be used to assess organ doses in
732 individuals of differing body size and organ morphometry. While reference computational
733 phantoms were created for the purpose of deriving radiological protection quantities, it
734 acknowledges that these phantoms have broader applications. However, one must be mindful of
735 the specific limitations related to their intended application.
736

737

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790 **ANNEX A. ID LISTINGS, MEDIUM, DENSITY, MASS,**
791 **MINIMUM/MAXIMUM COLUMNS, ROWS AND SLICES OCCUPIED BY**
792 **EACH ORGAN/TISSUE (CONTAINING RECTANGULAR PRISM), AND**
793 **ORGAN CENTRES OF MASS**

794 (A 1) Table A.1 lists the organ identification (ID) number, medium, density, and mass of each
795 organ/tissue. The organ ID is the number stored in the voxel array at the positions of those voxels
796 belonging to the respective organ/tissue. For the purpose of radiation transport calculations, a
797 material composition has to be assigned to the organs/tissues. The ‘medium’ numbers given here
798 refer to the elemental compositions of Annex B.

799 (A 2) Furthermore, for each organ, a rectangular prism (box) containing the organ
800 (minimum/maximum columns, rows, and slices occupied by the organ/tissue) is given to facilitate
801 the sampling of internal sources. Finally, the organ’s centre of mass (in terms of both voxels and
802 co-ordinate position) is also given (Tables A.2 to A.11 for all paediatric reference phantoms).

803 (A 3) The orientation of the three-dimensional voxel array describing the computational
804 phantom is as follows. The columns correspond to the x co-ordinates, the rows correspond to the
805 y co-ordinates, and the slices correspond to the z coordinates. Column numbers increase from right
806 to left, row numbers increase from front to back, and slice numbers increase from the toes up to
807 the vertex of the body.

808 Table A.1. ID listings, medium, and mass of each organ/tissue.

Organ ID	Medium	Mass (g)										
		Newborn Male	Newborn Female	1-Year Male	1-Year Female	5-Year Male	5-Year Female	10-Year Male	10-Year Female	15-Year Male	15-Year Female	
Adrenals												
1	Adrenal gland, left	43	2.99	2.99	2.00	2.00	2.48	2.48	3.54	3.54	5.32	4.56
2	Adrenal gland, right	43	2.97	2.97	1.98	1.98	2.50	2.50	3.45	3.45	4.67	4.42
Airways (and mouth)												
3	Anterior nasal passage (ET ₁)	45	0.09	0.09	0.14	0.14	0.45	0.45	0.48	0.48	2.02	0.43
4	Posterior nasal passage (ET ₂)	45	1.03	1.03	2.82	2.82	10.09	10.09	10.53	10.53	12.37	11.24
5	Oral mucosa, tongue	29	0.75	0.75	0.54	0.54	1.23	1.23	0.90	0.90	5.14	7.50
6	Oral mucosa, lips & cheeks	29	1.42	1.42	2.88	2.88	2.85	2.85	2.70	2.70	3.38	3.06
7	Trachea	45	0.50	0.50	1.50	1.50	2.50	2.50	4.52	4.52	7.48	6.02
8	Bronchi	45	0.38	0.38	1.98	1.98	3.43	3.43	2.92	2.92	7.42	6.84
Blood vessels												
9	Blood vessels, head	28	1.34	1.34	2.50	2.50	5.42	5.42	9.87	9.87	19.49	17.42
10	Blood vessels, trunk	28	0.50	0.50	0.77	0.77	2.16	2.16	4.97	4.97	8.69	6.63
11	Blood vessels, arms	28	4.54	4.54	9.37	9.37	23.91	23.91	51.63	51.63	95.80	85.30
12	Blood vessels, legs	28	5.37	5.37	12.70	12.70	34.32	34.32	73.12	73.12	137.69	129.16
Bones:												
Arm bones:												
13	Humeri, proximal end, cortical bone	2	1.99	1.99	12.72	12.72	28.51	28.51	87.49	87.49	150.97	123.34
14	Humeri, upper half, spongiosa	3	3.03	3.03	7.90	7.94	17.45	17.45	46.19	46.19	151.90	116.99
15	Humeri, upper half, medullary cavity	22	0.26	0.26	0.75	0.75	3.16	3.16	8.84	8.91	17.82	14.33
16	Humeri, lower half, cortical bone	2	1.76	1.76	9.31	9.31	21.97	21.97	67.32	67.32	170.90	133.47
17	Humeri, lower half, spongiosa	4	2.38	2.38	4.14	4.14	9.69	9.69	23.74	23.74	64.42	51.00
18	Humeri, lower half, medullary cavity	23	0.25	0.25	0.70	0.70	3.03	3.03	8.92	8.92	15.22	11.76
19	Ulnae and radii, cortical bone	2	2.77	2.77	13.09	13.09	33.27	33.28	98.62	98.62	218.58	185.61
20	Ulnae and radii, spongiosa	5	3.28	3.28	2.69	2.69	7.82	7.82	18.15	18.15	84.41	64.59
21	Ulnae and radii, medullary cavity	24	0.21	0.21	0.83	0.83	4.20	4.20	12.47	12.47	14.49	12.24
22	Wrists and hand bones, cortical bone	2	0.82	0.82	2.86	2.86	9.05	9.05	31.28	31.28	127.37	106.80
23	Wrists and hand bones, spongiosa	6	2.69	2.69	7.61	7.61	15.33	15.33	35.51	35.51	57.98	46.90
Clavicles												
24	Clavicles, cortical bone	2	0.91	0.91	1.27	1.27	6.07	6.07	15.17	15.17	41.54	54.82
25	Clavicles, spongiosa	7	1.42	1.42	1.79	1.79	6.96	6.96	14.86	14.86	18.67	23.36
Cranium												
26	Cranium, cortical bone	2	21.19	21.21	91.60	91.60	215.88	215.88	308.42	308.42	528.51	412.05
27	Cranium, spongiosa	8	69.71	69.71	266.80	266.80	462.09	462.09	444.85	444.83	421.38	363.55
Leg bones:												
28	Femora proximal end, cortical bone	2	3.80	3.80	14.11	14.11	48.42	48.42	162.10	162.10	312.78	233.80
29	Femora upper half, spongiosa	9	4.95	4.95	8.04	8.04	22.76	22.76	66.20	66.20	219.16	164.01
30	Femora upper half, medullary cavity	22	0.58	0.58	0.85	0.85	6.92	6.92	22.88	22.88	44.06	32.20
31	Femora lower half, cortical bone	2	5.48	5.48	20.47	20.47	47.03	47.03	151.16	151.16	242.45	253.21
32	Femora lower half, spongiosa	10	4.11	4.11	7.97	7.97	25.47	25.47	81.41	81.41	278.58	247.15
33	Femora lower half, medullary cavity	23	0.92	0.92	1.39	1.39	4.84	4.84	15.53	15.53	34.06	36.24
34	Tibiae, fibulae, and patellae, cortical bone	2	5.68	5.67	29.57	29.57	82.83	82.82	272.83	272.83	471.03	392.25
35	Tibiae, fibulae, and patellae, spongiosa	11	7.06	7.06	7.68	7.68	27.67	27.67	75.77	75.77	299.30	255.27
36	Tibiae, fibulae, and patellae, medullary cavity	25	0.61	0.61	2.05	2.05	8.81	8.81	30.04	30.04	65.53	53.22
37	Ankles and foot bones, cortical bone	2	1.23	1.23	7.17	7.17	32.19	32.19	89.68	89.68	215.01	172.99
38	Ankles and foot bones, spongiosa	12	3.98	3.98	18.89	18.86	64.98	64.98	151.21	151.21	365.80	291.71
39	Mandible, cortical bone	2	1.68	1.68	7.17	7.17	17.26	17.26	21.41	21.41	51.83	41.96
40	Mandible, spongiosa	13	4.80	4.80	12.02	12.02	22.35	22.35	19.08	19.08	28.45	21.88

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811 Table A.1. (continued)

Organ ID	Medium	Mass (g)										
		Newborn Male	Newborn Female	1-Year Male	1-Year Female	5-Year Male	5-Year Female	10-Year Male	10-Year Female	15-Year Male	15-Year Female	
Pelvis												
41	Pelvis, cortical bone	2	6.13	6.13	21.17	21.17	55.44	55.44	125.77	125.77	193.74	214.22
42	Pelvis, spongiosa	14	7.31	7.31	30.69	30.69	87.85	87.85	252.19	252.19	439.18	487.13
Ribs												
43	Ribs, cortical bone	2	6.11	6.11	20.68	20.68	39.44	39.44	67.47	67.45	166.61	181.55
44	Ribs, spongiosa	15	18.01	18.01	51.98	51.98	71.90	71.90	121.69	121.68	167.80	180.06
Scapulae												
45	Scapulae, cortical bone	2	2.40	2.40	9.65	9.65	28.28	28.28	58.76	58.76	116.05	170.51
46	Scapulae, spongiosa	16	3.78	3.78	13.43	13.43	37.30	37.30	80.06	80.06	100.13	128.94
Spine												
47	Cervical spine, cortical bone	2	3.63	3.63	3.17	3.17	6.74	6.74	13.58	13.59	32.72	41.73
48	Cervical spine, spongiosa	17	6.21	6.21	8.20	8.20	12.02	12.02	26.86	26.85	48.02	59.08
49	Thoracic spine, cortical bone	2	8.43	8.43	11.56	11.56	31.69	31.69	69.66	69.66	86.03	70.84
50	Thoracic spine, spongiosa	18	9.12	9.12	25.01	25.01	64.43	64.43	184.54	184.54	223.29	203.52
51	Lumbar spine, cortical bone	2	2.66	2.66	7.01	7.01	15.88	15.88	37.53	37.53	35.12	48.86
52	Lumbar spine, spongiosa	19	6.73	6.73	19.77	19.77	51.16	51.16	141.31	141.31	216.45	232.75
Sacrum												
53	Sacrum, cortical bone	2	1.10	1.10	6.60	6.60	11.12	11.12	15.72	15.72	68.93	86.85
54	Sacrum, spongiosa	20	2.69	2.69	13.58	13.58	29.99	29.99	49.40	49.40	102.37	124.05
Sternum												
55	Sternum, cortical bone	2	0.17	0.17	0.61	0.61	2.42	2.42	5.25	5.25	22.47	16.27
56	Sternum, spongiosa	21	0.57	0.57	1.89	1.89	7.29	7.29	18.35	18.35	35.82	24.61
Cartilage												
57	Cartilage, head	26	55.48	55.54	14.19	14.19	16.87	16.87	23.10	23.10	33.89	26.33
58	Cartilage, trunk	26	47.46	47.46	34.06	34.06	55.15	55.15	117.29	117.29	136.67	147.02
59	Cartilage, arms	26	11.52	11.52								
60	Cartilage, legs	26	14.41	14.41								
61	Brain	32	316.72	316.72	949.68	949.68	1244.65	1244.65	1309.23	1309.23	1419.16	1296.02
Breasts												
62	Breast, left, adipose tissue	49	0.12	0.12	0.70	0.70	1.66	1.66	2.61	2.61	4.54	35.28
63	Breast, left, glandular tissue	48	0.05	0.05	0.35	0.35	0.74	0.74	1.27	1.27	2.73	90.00
64	Breast, right, adipose tissue	49	0.12	0.12	0.70	0.70	1.66	1.66	2.61	2.61	4.90	35.29
65	Breast, right, glandular tissue	48	0.05	0.05	0.35	0.35	0.74	0.74	1.27	1.27	2.76	90.00
Eyes												
66	Eye lens, left	34	0.06	0.06	0.10	0.10	0.17	0.17	0.17	0.17	0.23	0.20
67	Eye bulb, left	34	3.29	3.22	3.55	3.55	5.58	5.58	6.11	6.11	6.67	6.63
68	Eye lens, right	34	0.06	0.06	0.10	0.10	0.17	0.17	0.17	0.17	0.23	0.20
69	Eye bulb, right	34	2.81	2.89	3.55	3.55	5.58	5.58	6.11	6.11	6.67	6.63
Gallbladder												
70	Gallbladder wall	45	0.50	0.50	1.41	1.41	2.60	2.60	4.37	4.37	7.70	7.23
71	Gallbladder contents	45	2.81	2.81	8.00	8.00	14.98	14.98	25.94	25.94	44.85	42.06
Gastrointestinal tract												
72	Stomach wall	36	6.98	6.98	19.90	19.90	50.04	49.94	84.85	84.85	119.58	119.53
73	Stomach contents	51	25.34	25.35	67.20	67.19	82.74	82.72	116.95	116.92	198.64	199.94
74	Small intestine wall	37	29.81	29.79	84.56	84.41	218.52	218.31	369.29	369.42	516.35	521.62
75	Small intestine contents	51	31.64	31.74	48.21	48.33	36.60	36.92	163.00	163.00	280.00	280.00
76	Ascending colon wall	38	2.96	2.96	9.26	9.26	31.10	31.19	54.59	55.33	76.29	69.01
77	Ascending colon contents	51	6.63	6.63	7.19	7.19	17.28	17.29	18.33	18.33	45.26	24.69

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814 Table A.1. (continued)

Organ ID	Medium	Mass (g)										
		Newborn Male	Newborn Female	1-Year Male	1-Year Female	5-Year Male	5-Year Female	10-Year Male	10-Year Female	15-Year Male	15-Year Female	
78	Transverse colon wall, right	38	4.02	4.02	10.63	10.63	17.60	17.60	28.98	28.98	45.43	52.54
79	Transverse colon content, right	51	8.99	8.99	8.25	8.25	9.76	9.76	9.69	9.69	26.98	19.03
80	Transverse colon wall, left	38	4.50	4.50	11.43	11.43	33.09	33.09	58.94	58.94	76.64	82.33
81	Transverse colon content, left	51	7.73	7.73	11.67	11.67	16.92	16.92	11.49	11.49	19.48	40.34
82	Descending colon wall, left	38	2.47	2.48	8.48	8.52	15.48	15.48	25.47	25.47	44.75	38.95
83	Descending colon content, left	51	4.26	4.26	8.18	8.19	7.95	7.95	5.03	5.03	9.33	19.28
84	Sigmoid colon wall	38	2.85	2.82	9.21	9.22	20.90	20.90	37.31	37.30	49.18	54.29
85	Sigmoid colon content	51	9.63	9.65	14.55	14.54	25.00	25.00	32.04	32.02	60.00	52.25
86	Rectum wall	38	0.17	0.17	0.76	0.76	1.12	1.12	2.79	2.79	6.34	2.02
Heart												
87	Heart wall	33	19.90	19.90	50.09	50.09	84.65	84.65	139.20	139.19	229.96	220.18
88	Heart chamber contents (blood)	28	6.05	6.05	47.94	47.94	134.84	134.84	229.32	229.32	428.72	318.88
Kidneys												
89	Kidney, left, cortex	35	9.19	9.19	25.75	25.75	40.37	40.37	66.01	66.01	91.93	88.20
90	Kidney, left, medulla	35	3.28	3.28	9.15	9.15	14.40	14.40	23.66	23.66	32.88	31.52
91	Kidney, left, pelvis	35	0.66	0.66	1.83	1.83	2.92	2.92	4.71	4.71	6.53	6.33
92	Kidney, right cortex	35	9.19	9.19	25.73	25.73	40.43	40.43	66.00	66.00	91.74	88.03
93	Kidney, right medulla	35	3.27	3.27	9.15	9.15	14.45	14.45	23.65	23.65	32.93	31.62
94	Kidney, right pelvis	35	0.65	0.65	1.82	1.82	2.86	2.86	4.70	4.70	6.57	6.25
95	Liver	30	129.68	129.67	329.50	329.50	569.19	569.19	828.35	828.39	1298.39	1299.44
Lungs												
96	Lung, left, blood	28	1.04	1.04	3.42	3.42	8.09	8.09	12.39	12.39	18.39	18.74
97	Lung, left, air-filled tissue	50	26.87	26.87	66.35	66.35	131.45	131.45	220.17	220.17	400.21	330.09
98	Lung, right blood	28	0.53	0.53	1.74	1.74	4.80	4.80	8.30	8.30	12.55	12.56
99	Lung, right air-filled tissue	50	31.56	31.56	78.49	78.49	155.67	155.67	259.14	259.14	468.85	388.61
Lymphatic nodes												
100	Lymphatic nodes, ET airways	47	1.19	1.17	1.97	1.98	4.20	3.96	6.54	6.74	11.54	10.48
101	Lymphatic nodes, thoracic airways	47	1.30	1.40	1.97	1.93	4.33	3.89	6.58	6.57	11.35	10.75
102	Lymphatic nodes, head	47	0.44	0.44	0.68	0.67	1.22	1.40	2.43	2.43	4.21	3.60
103	Lymphatic nodes, trunk	47	9.69	9.68	17.37	17.37	33.53	33.55	55.70	56.41	98.47	89.62
104	Lymphatic nodes, arms	47	0.81	0.81	1.53	1.53	2.76	2.92	4.71	4.56	8.47	7.73
105	Lymphatic nodes, legs	47	0.81	0.81	1.53	1.53	2.85	2.85	4.71	4.71	8.48	7.73
Muscle (skeletal)												
106	Muscle, head	29	174.61	175.12	666.64	667.64	796.11	804.44	796.19	796.43	904.78	929.41
107	Muscle, trunk	29	269.71	267.84	342.37	341.20	1289.02	1279.02	3645.60	3644.86	6631.02	3369.63
108	Muscle, arms	29	105.76	106.14	259.55	259.64	648.85	649.28	1551.42	1551.76	3768.33	3091.03
109	Muscle, legs	29	250.20	251.14	631.44	631.52	2866.02	2867.26	5006.80	5006.95	12696.00	9609.75
110	Oesophagus wall	44	2.00	2.00	5.01	5.02	9.91	10.01	17.96	18.00	29.72	29.79
Ovaries												
111	Ovary, left	42		0.15		0.39		0.99		1.73		3.04
112	Ovary, right	42		0.15		0.40		0.99		1.73		2.97
113	Pancreas	31	5.98	5.98	19.95	19.95	34.91	34.91	59.70	59.70	109.81	99.86
114	Pituitary gland	45	0.10	0.10	0.15	0.15	0.25	0.25	0.35	0.35	0.50	0.50
115	Prostate	46	0.80		1.00		1.20		1.60		4.29	
Residual tissue												
116	Residual tissue, head	49	67.13	66.62	224.81	223.99	280.05	272.52	242.17	241.89	139.01	354.49
117	Residual tissue, trunk	49	973.66	970.97	3297.38	3297.12	4630.14	4625.76	8672.80	8666.79	12649.67	13849.32
118	Residual tissue, arms	49	112.82	113.85	303.05	304.60	666.20	665.57	503.12	505.71	887.62	1112.57

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817 Table A.1. (continued)

Organ ID	Medium	Mass (g)										
		Newborn Male	Newborn Female	1-Year Male	1-Year Female	5-Year Male	5-Year Female	10-Year Male	10-Year Female	15-Year Male	15-Year Female	
119	Residual tissue, legs	49	240.95	240.98	1010.42	1010.80	1850.86	1862.78	1807.49	1807.05	2133.43	5483.63
	Salivary glands											
120	Salivary glands, left	45	2.99	2.99	11.96	11.96	16.97	16.97	21.88	21.88	33.77	32.62
121	Salivary glands, right	45	2.99	2.99	12.00	12.00	16.97	16.97	21.88	21.88	34.05	32.65
	Skin											
122	Skin, head	27	21.48	21.48	46.08	46.08	71.04	71.04	84.44	84.44	115.68	113.38
123	Skin, trunk	27	48.62	47.90	93.54	92.47	184.02	182.16	344.42	342.32	623.84	556.54
124	Skin, arms	27	19.50	19.54	43.62	43.67	103.39	103.39	191.67	191.77	382.03	325.39
125	Skin, legs	27	27.79	27.79	70.31	70.31	214.66	215.12	359.45	359.42	732.16	681.86
126	Spinal cord	45	6.42	6.42	23.80	23.79	31.56	31.56	51.79	51.79	48.25	57.01
127	Spleen	39	9.47	9.47	28.98	28.98	49.90	49.90	79.61	79.61	129.58	129.20
128	Teeth	1					14.91	14.91	29.82	29.82	45.04	34.92
	Testes											
129	Testis, left	42	0.42		0.75		0.84		1.00		8.00	
130	Testis, right	42	0.42		0.75		0.84		0.99		7.99	
131	Thymus	45	12.93	12.93	16.07	16.07	30.09	30.09	37.31	37.31	35.14	29.90
132	Thyroid	40	1.30	1.30	1.80	1.80	3.39	3.39	7.91	7.91	12.01	11.97
133	Tongue (inner part)	29	3.50	3.50	10.00	10.00	18.92	18.92	31.95	31.95	55.45	53.06
134	Tonsils	45	0.10	0.10	0.50	0.50	1.99	1.99	3.00	3.01	3.03	3.01
	Ureters											
135	Ureter, left	45	0.18	0.18	0.31	0.31	0.91	0.91	1.33	1.33	2.30	2.66
136	Ureter, right	45	0.18	0.18	0.31	0.31	0.91	0.91	1.37	1.37	2.35	2.55
137	Urinary bladder wall	41	3.97	3.97	9.00	9.01	15.97	15.95	24.95	24.87	39.78	34.88
138	Urinary bladder contents	52	10.02	10.05	11.01	10.08	61.68	61.66	98.43	98.36	153.31	134.14
139	Uterus and cervix	46		3.96		1.50		2.99		3.99		29.94
140	Air inside the body	53	0.00	0.00	0.01	0.01	0.04	0.04	0.07	0.07	0.50	0.17

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Table A.2. ID listings, rectangular prism (box) containing the organ (minimum/maximum columns, rows, and slices occupied by each organ/tissue), and organs centres of mass (in terms of voxels as well as co-ordinates) for the *newborn male phantom*.

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
Adrenals													
1	Adrenal gland, left	180	221	148	168	367	404	196.29	158.72	385.18	13.01	10.52	25.54
2	Adrenal gland, right	129	164	138	175	363	395	149.11	155.83	374.17	9.89	10.33	24.81
Airways (and mouth)													
3	Anterior nasal passage (ET ₁)	164	181	40	47	576	589	172.68	43.03	580.87	11.45	2.85	38.51
4	Posterior nasal passage (ET ₂)	164	180	44	127	560	617	171.74	77.12	590.23	11.39	5.11	39.13
5	Oral mucosa, tongue	158	188	77	115	544	572	172.47	98.92	562.48	11.43	6.56	37.29
6	Oral mucosa, lips & cheeks	145	202	48	74	543	578	173.68	60.30	560.24	11.51	4.00	37.14
7	Trachea	169	177	127	144	492	533	172.49	134.90	511.27	11.44	8.94	33.90
8	Bronchi	161	190	135	143	470	491	174.03	138.28	480.09	11.54	9.17	31.83
Blood vessels													
9	Blood vessels, head	106	240	133	153	520	585	172.50	138.19	549.01	11.44	9.16	36.40
10	Blood vessels, trunk	159	187	136	165	389	544	172.32	151.00	471.92	11.42	10.01	31.29
11	Blood vessels, arms	35	311	114	156	326	523	172.50	135.64	423.58	11.44	8.99	28.08
12	Blood vessels, legs	28	318	79	133	40	261	172.50	102.79	166.50	11.44	6.81	11.04
Bones:													
Arm bones:													
13	Humeri, proximal end, cortical bone	69	277	129	147	474	519	172.50	138.55	490.47	11.44	9.19	32.52
14	Humeri, upper half, spongiosa	68	278	109	146	185	519	172.50	137.64	506.56	11.44	9.13	33.58
15	Humeri, upper half, medullary cavity	72	274	136	143	475	496	172.50	139.17	485.82	11.44	9.23	32.21
16	Humeri, lower half, cortical bone	44	302	136	147	427	477	172.50	141.51	459.26	11.44	9.38	30.45
17	Humeri, lower half, spongiosa	44	302	136	147	428	455	172.50	141.38	440.17	11.44	9.37	29.18
18	Humeri, lower half, medullary cavity	60	286	139	144	452	476	172.50	141.13	462.93	11.44	9.36	30.69
19	Ulnae and radii, cortical bone	40	306	74	150	105	420	172.54	131.34	376.05	11.44	8.71	24.93
20	Ulnae and radii, spongiosa	41	305	110	149	334	420	172.50	130.91	376.43	11.44	8.68	24.96
21	Ulnae and radii, medullary cavity	43	303	117	144	356	398	172.50	130.79	375.99	11.44	8.67	24.93
22	Wrists and hand bones, cortical bone	39	307	91	141	256	323	172.50	114.42	290.94	11.44	7.59	19.29
23	Wrists and hand bones, spongiosa	39	307	91	141	256	323	172.50	113.53	293.06	11.44	7.53	19.43
Clavicles													
24	Clavicles, cortical bone	113	233	110	150	518	541	172.50	130.11	529.67	11.44	8.63	35.12
25	Clavicles, spongiosa	113	233	111	150	519	540	172.50	129.70	529.67	11.44	8.60	35.12
Cranium													
26	Cranium, cortical bone	112	238	45	203	569	710	173.87	119.84	632.81	11.53	7.95	41.96
27	Cranium, spongiosa	112	238	45	202	570	710	173.03	115.36	619.92	11.47	7.65	41.10
Leg bones:													
28	Femora proximal end, cortical bone	87	259	126	162	208	249	172.50	140.55	224.60	11.44	9.32	14.89
29	Femora upper half, spongiosa	108	238	139	162	222	248	172.50	149.83	235.24	11.44	9.93	15.60
30	Femora upper half, medullary cavity	88	258	128	149	212	232	172.50	138.53	222.11	11.44	9.18	14.73
31	Femora lower half, cortical bone	47	299	96	135	168	218	172.50	117.92	195.07	11.44	7.82	12.93
32	Femora lower half, spongiosa	47	299	97	121	169	194	172.50	108.26	181.08	11.44	7.18	12.01
33	Femora lower half, medullary cavity	59	287	107	132	188	216	172.50	118.41	199.79	11.44	7.85	13.25
34	Tibiae, fibulae, and patellae, cortical bone	35	311	73	100	55	168	172.48	82.11	105.80	11.44	5.44	7.01
35	Tibiae, fibulae, and patellae, spongiosa	35	311	74	100	55	168	172.50	83.92	109.60	11.44	5.56	7.27
36	Tibiae, fibulae, and patellae, medullary cavity	39	307	77	95	77	129	172.50	80.60	104.18	11.44	5.34	6.91
37	Ankles and foot bones, cortical bone	13	333	12	103	7	37	172.50	62.88	18.86	11.44	4.17	1.25
38	Ankles and foot bones, spongiosa	14	332	12	103	7	36	172.50	68.72	19.23	11.44	4.56	1.28
39	Mandible, cortical bone	127	216	65	112	536	590	169.83	87.11	561.83	11.26	5.78	37.25
40	Mandible, spongiosa	127	215	65	112	537	589	170.79	85.89	559.41	11.32	5.69	37.09

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825 Table A.2. (continued – *newborn male phantom*)

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
Pelvis													
41	Pelvis, cortical bone	114	232	137	183	226	301	172.50	158.30	268.09	11.44	10.50	17.77
42	Pelvis, spongiosa	115	231	138	182	228	300	172.50	158.77	268.37	11.44	10.53	17.79
Ribs													
43	Ribs, cortical bone	100	246	90	179	379	521	172.41	147.01	452.24	11.43	9.75	29.98
44	Ribs, spongiosa	100	246	91	179	379	521	172.49	147.19	453.08	11.44	9.76	30.04
Scapulae													
45	Scapulae, cortical bone	104	242	145	180	480	529	172.50	163.62	508.04	11.44	10.85	33.68
46	Scapulae, spongiosa	105	241	145	179	481	529	172.50	162.28	509.14	11.44	10.76	33.76
Spine													
47	Cervical spine, cortical bone	150	199	131	179	512	582	172.63	153.88	547.44	11.45	10.20	36.29
48	Cervical spine, spongiosa	151	201	132	179	512	581	172.70	152.59	549.07	11.45	10.12	36.40
49	Thoracic spine, cortical bone	154	193	151	185	373	516	172.00	169.89	446.41	11.40	11.26	29.60
50	Thoracic spine, spongiosa	156	191	152	184	374	515	171.97	168.28	445.28	11.40	11.16	29.52
51	Lumbar spine, cortical bone	156	189	147	182	297	375	171.99	164.09	336.87	11.40	10.88	22.33
52	Lumbar spine, spongiosa	157	188	147	182	298	375	171.81	161.17	335.72	11.39	10.69	22.26
Sacrum													
53	Sacrum, cortical bone	151	191	154	194	248	296	170.80	172.37	279.01	11.32	11.43	18.50
54	Sacrum, spongiosa	151	190	154	193	249	296	170.71	170.36	279.10	11.32	11.30	18.50
Sternum													
55	Sternum, cortical bone	166	181	72	101	448	505	172.46	86.43	481.21	11.43	5.73	31.90
56	Sternum, spongiosa	166	181	72	101	448	504	172.58	86.60	481.49	11.44	5.74	31.92
Cartilage													
57	Cartilage, head	102	244	37	204	531	713	173.63	118.96	636.78	11.51	7.89	42.22
58	Cartilage, trunk	52	295	64	195	25	585	172.28	138.89	419.00	11.42	9.21	27.78
59	Cartilage, arms	36	310	89	152	254	521	172.50	126.70	371.79	11.44	8.40	24.65
60	Cartilage, legs	12	334	11	165	6	251	172.50	94.07	116.39	11.44	6.24	7.72
61	Brain	115	232	49	198	562	708	172.69	127.58	651.14	11.45	8.46	43.17
Breasts													
62	Breast, left, adipose tissue	206	220	54	59	445	458	212.42	56.25	450.83	14.08	3.73	29.89
63	Breast, left, glandular tissue	209	217	55	59	447	455	212.39	56.26	450.65	14.08	3.73	29.88
64	Breast, right, adipose tissue	126	140	54	59	445	458	132.58	56.25	450.83	8.79	3.73	29.89
65	Breast, right, glandular tissue	129	137	55	59	447	455	132.61	56.26	450.65	8.79	3.73	29.88
Eyes													
66	Eye lens, left	193	202	52	56	603	611	197.06	53.24	606.09	13.06	3.53	40.18
67	Eye bulb, left	184	211	47	80	595	617	197.24	63.51	606.13	13.08	4.21	40.19
68	Eye lens, right	142	150	54	57	600	609	145.18	55.13	604.00	9.63	3.66	40.05
69	Eye bulb, right	133	158	50	80	593	615	145.15	64.94	604.24	9.62	4.31	40.06
Gallbladder													
70	Gallbladder wall	134	161	89	126	354	384	147.31	106.22	368.51	9.77	7.04	24.43
71	Gallbladder contents	135	160	90	125	355	383	146.84	105.97	368.40	9.74	7.03	24.43
Gastrointestinal tract													
72	Stomach wall	160	231	82	145	345	416	198.17	110.57	377.73	13.14	7.33	25.04
73	Stomach contents	162	229	83	142	348	413	200.41	109.10	378.49	13.29	7.23	25.09
74	Small intestine wall	113	241	79	137	255	375	178.49	104.33	310.75	11.83	6.92	20.60
75	Small intestine contents	116	239	81	135	258	372	178.22	104.44	310.95	11.82	6.92	20.62
76	Ascending colon wall	95	125	72	116	267	360	108.59	97.67	312.92	7.20	6.48	20.75
77	Ascending colon contents	97	123	74	114	268	359	109.02	97.66	312.89	7.23	6.47	20.74

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828 Table A.2. (continued – *newborn male phantom*)

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
78	Transverse colon wall, right	112	176	60	94	286	374	151.96	73.94	339.18	10.08	4.90	22.49
79	Transverse colon content, right	114	175	61	92	288	372	152.02	73.91	339.05	10.08	4.90	22.48
80	Transverse colon wall, left	170	245	58	104	284	381	201.76	75.13	340.02	13.38	4.98	22.54
81	Transverse colon content, left	170	244	59	102	286	380	201.73	75.05	339.93	13.37	4.98	22.54
82	Descending colon wall, left	221	255	80	139	275	362	240.98	112.30	318.80	15.98	7.45	21.14
83	Descending colon content, left	222	253	82	137	276	361	240.51	112.43	318.76	15.95	7.45	21.13
84	Sigmoid colon wall	143	238	120	158	236	301	183.78	139.91	271.44	12.18	9.28	18.00
85	Sigmoid colon content	144	236	121	157	217	300	186.53	138.49	272.18	12.37	9.18	18.05
86	Rectum wall	160	177	141	157	217	235	168.34	148.87	226.44	11.16	9.87	15.01
Heart													
87	Heart wall	149	212	80	136	439	483	180.94	106.55	460.25	12.00	7.06	30.51
88	Heart chamber contents (blood)	155	200	88	126	444	475	178.07	106.99	461.27	11.81	7.09	30.58
Kidneys													
89	Kidney, left, cortex	191	229	129	169	308	374	212.23	150.03	343.36	14.07	9.95	22.76
90	Kidney, left, medulla	195	221	136	160	318	364	209.40	147.28	341.92	13.88	9.76	22.67
91	Kidney, left, pelvis	201	215	144	157	329	353	208.04	150.20	341.64	13.79	9.96	22.65
92	Kidney, right cortex	121	159	125	165	299	365	136.23	145.72	334.47	9.03	9.66	22.18
93	Kidney, right medulla	128	154	131	156	309	355	139.00	143.07	333.27	9.22	9.49	22.10
94	Kidney, right pelvis	135	149	139	153	321	344	140.28	145.99	332.90	9.30	9.68	22.07
95	Liver	95	222	70	167	307	445	141.85	116.83	396.59	9.40	7.75	26.29
Lungs													
96	Lung, left, blood	191	227	107	159	438	499	206.94	141.91	464.19	13.72	9.41	30.78
97	Lung, left, air-filled tissue	182	239	89	172	419	510	209.46	136.52	461.94	13.89	9.05	30.63
98	Lung, right blood	118	155	108	164	439	504	141.72	138.97	463.01	9.40	9.21	30.70
99	Lung, right air-filled tissue	109	177	81	169	427	509	139.44	132.73	465.14	9.25	8.80	30.84
Lymphatic nodes													
100	Lymphatic nodes, ET airways	143	201	88	141	528	589	171.50	115.34	567.54	11.37	7.65	37.63
101	Lymphatic nodes, thoracic airways	144	200	124	175	353	512	172.42	149.28	424.55	11.43	9.90	28.15
102	Lymphatic nodes, head	142	202	137	153	514	559	171.50	144.50	529.17	11.37	9.58	35.08
103	Lymphatic nodes, trunk	93	251	51	196	204	525	171.50	144.49	319.14	11.37	9.58	21.16
104	Lymphatic nodes, arms	47	297	119	158	354	478	171.50	134.59	418.32	11.37	8.92	27.73
105	Lymphatic nodes, legs	38	306	84	114	112	178	171.50	96.77	150.32	11.37	6.42	9.97
Muscle (skeletal)													
106	Muscle, head	109	236	43	202	536	714	172.33	118.95	600.87	11.43	7.89	39.84
107	Muscle, trunk	80	266	42	200	191	552	172.40	120.75	391.77	11.43	8.01	25.97
108	Muscle, arms	37	309	89	170	250	507	172.51	132.22	403.91	11.44	8.77	26.78
109	Muscle, legs	2	344	2	172	3	280	172.42	104.17	152.00	11.43	6.91	10.08
110	Oesophagus wall	169	190	133	151	397	548	175.56	145.34	472.33	11.64	9.64	31.32
Ovaries													
111	Ovary, left												
112	Ovary, right												
113	Pancreas	173	247	111	143	348	373	215.31	128.16	359.98	14.28	8.50	23.87
114	Pituitary gland	168	175	97	104	619	627	171.08	100.03	622.64	11.34	6.63	41.28
115	Prostate	165	183	110	126	214	232	173.16	117.40	223.88	11.48	7.78	14.84
Residual tissue													
116	Residual tissue, head	106	240	39	206	534	715	170.68	125.17	635.84	11.32	8.30	42.16
117	Residual tissue, trunk	50	295	39	210	188	552	174.16	126.66	374.59	11.55	8.40	24.84
118	Residual tissue, arms	34	312	88	180	250	512	172.52	133.87	423.56	11.44	8.88	28.08

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831 Table A.2. (continued – *newborn male phantom*)

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
119	Residual tissue, legs	2	344	2	182	2	285	171.92	114.41	186.41	11.40	7.59	12.36
	Salivary glands												
120	Salivary glands, left	175	220	80	132	538	590	198.81	111.62	561.03	13.18	7.40	37.20
121	Salivary glands, right	126	171	80	132	538	590	146.19	111.62	561.03	9.69	7.40	37.20
	Skin												
122	Skin, head	101	245	36	207	534	716	172.42	122.41	628.52	11.43	8.12	41.67
123	Skin, trunk	48	296	38	211	188	552	172.74	125.49	380.55	11.45	8.32	25.23
124	Skin, arms	33	313	87	181	250	497	172.36	127.57	371.50	11.43	8.46	24.63
125	Skin, legs	1	345	1	183	1	258	172.51	96.40	128.43	11.44	6.39	8.51
126	Spinal cord	166	179	147	191	260	560	172.22	168.93	423.95	11.42	11.20	28.11
127	Spleen	197	242	114	159	372	421	224.51	141.16	394.72	14.89	9.36	26.17
128	Teeth												
	Testes												
129	Testis, left	175	186	105	116	189	206	179.84	109.69	197.37	11.92	7.27	13.09
130	Testis, right	160	171	105	116	189	206	165.16	109.69	197.37	10.95	7.27	13.09
131	Thymus	150	196	95	134	481	524	173.56	113.64	500.62	11.51	7.53	33.19
132	Thyroid	157	191	115	134	530	554	173.01	122.23	541.33	11.47	8.10	35.89
133	Tongue (inner part)	159	187	78	115	544	571	172.49	99.59	558.34	11.44	6.60	37.02
134	Tonsils	160	185	108	114	563	570	172.09	110.42	566.22	11.41	7.32	37.54
	Ureters												
135	Ureter, left	179	200	120	147	266	336	187.56	132.38	302.65	12.44	8.78	20.07
136	Ureter, right	146	167	120	147	266	336	157.43	132.40	302.70	10.44	8.78	20.07
137	Urinary bladder wall	145	201	94	137	232	268	172.56	114.99	249.66	11.44	7.62	16.55
138	Urinary bladder contents	148	198	97	134	235	266	172.54	114.87	249.84	11.44	7.62	16.56
139	Uterus and cervix												
140	Air inside the body	161	188	41	142	472	616	172.47	100.96	550.83	11.44	6.69	36.52

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835 Table A.3. ID listings, rectangular prism (box) containing the organ (minimum/maximum
 836 columns, rows, and slices occupied by each organ/tissue), and organs centres of mass (in terms of
 837 voxels as well as co-ordinates) for the *newborn female phantom*.

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
Adrenals													
1	Adrenal gland, left	180	221	148	168	367	404	196.29	158.72	385.18	13.01	10.52	25.54
2	Adrenal gland, right	129	164	138	175	363	395	149.11	155.83	374.17	9.89	10.33	24.81
Airways (and mouth)													
3	Anterior nasal passage (ET ₁)	164	181	40	47	576	589	172.68	43.03	580.87	11.45	2.85	38.51
4	Posterior nasal passage (ET ₂)	164	180	44	127	560	617	171.74	77.12	590.23	11.39	5.11	39.13
5	Oral mucosa, tongue	158	188	77	115	544	572	172.47	98.92	562.48	11.43	6.56	37.29
6	Oral mucosa, lips & cheeks	145	202	48	74	543	578	173.68	60.30	560.24	11.51	4.00	37.14
7	Trachea	169	177	127	144	492	533	172.49	134.90	511.28	11.44	8.94	33.90
8	Bronchi	161	190	135	143	470	491	174.03	138.28	480.09	11.54	9.17	31.83
Blood vessels													
9	Blood vessels, head	106	240	133	153	520	585	172.50	138.19	549.01	11.44	9.16	36.40
10	Blood vessels, trunk	159	187	136	165	389	544	172.32	151.00	471.92	11.42	10.01	31.29
11	Blood vessels, arms	35	311	114	156	326	523	172.50	135.64	423.58	11.44	8.99	28.08
12	Blood vessels, legs	28	318	79	133	40	261	172.50	102.79	166.50	11.44	6.81	11.04
Bones:													
Arm bones:													
13	Humeri, proximal end, cortical bone	69	277	129	147	474	519	172.50	138.55	490.47	11.44	9.19	32.52
14	Humeri, upper half, spongiosa	68	279	109	151	185	519	172.51	137.64	506.24	11.44	9.13	33.56
15	Humeri, upper half, medullary cavity	72	274	136	143	475	496	172.50	139.17	485.82	11.44	9.23	32.21
16	Humeri, lower half, cortical bone	44	302	136	147	427	477	172.50	141.51	459.26	11.44	9.38	30.45
17	Humeri, lower half, spongiosa	44	302	136	147	428	455	172.50	141.38	440.17	11.44	9.37	29.18
18	Humeri, lower half, medullary cavity	60	286	139	144	452	476	172.50	141.13	462.93	11.44	9.36	30.69
19	Ulnae and radii, cortical bone	40	306	74	150	105	420	172.63	131.29	375.81	11.45	8.70	24.92
20	Ulnae and radii, spongiosa	41	305	110	149	334	420	172.50	130.91	376.43	11.44	8.68	24.96
21	Ulnae and radii, medullary cavity	43	303	117	144	356	398	172.50	130.79	375.99	11.44	8.67	24.93
22	Wrists and hand bones, cortical bone	39	307	91	141	256	323	172.50	114.42	290.94	11.44	7.59	19.29
23	Wrists and hand bones, spongiosa	39	307	91	141	256	323	172.50	113.53	293.06	11.44	7.53	19.43
Clavicles													
24	Clavicles, cortical bone	113	233	110	150	518	541	172.50	130.11	529.67	11.44	8.63	35.12
25	Clavicles, spongiosa	113	233	111	150	519	540	172.50	129.70	529.67	11.44	8.60	35.12
Cranium													
26	Cranium, cortical bone	112	238	45	203	569	710	173.89	119.79	632.78	11.53	7.94	41.95
27	Cranium, spongiosa	112	238	45	202	570	710	173.03	115.36	619.92	11.47	7.65	41.10
Leg bones:													
28	Femora proximal end, cortical bone	87	259	126	162	208	249	172.50	140.55	224.60	11.44	9.32	14.89
29	Femora upper half, spongiosa	108	238	139	162	222	248	172.50	149.83	235.24	11.44	9.93	15.60
30	Femora upper half, medullary cavity	88	258	128	149	212	232	172.50	138.53	222.11	11.44	9.18	14.73
31	Femora lower half, cortical bone	47	299	96	135	168	218	172.50	117.92	195.07	11.44	7.82	12.93
32	Femora lower half, spongiosa	47	299	97	121	169	194	172.49	108.26	181.08	11.44	7.18	12.01
33	Femora lower half, medullary cavity	59	287	107	132	188	216	172.50	118.41	199.79	11.44	7.85	13.25
34	Tibiae, fibulae, and patellae, cortical bone	35	311	73	100	55	168	172.44	82.12	105.80	11.43	5.44	7.01
35	Tibiae, fibulae, and patellae, spongiosa	35	311	74	100	55	168	172.50	83.92	109.60	11.44	5.56	7.27
36	Tibiae, fibulae, and patellae, medullary cavity	39	307	77	95	77	129	172.50	80.60	104.18	11.44	5.34	6.91
37	Ankles and foot bones, cortical bone	13	333	12	103	7	37	172.50	62.88	18.86	11.44	4.17	1.25
38	Ankles and foot bones, spongiosa	14	332	12	103	7	36	172.50	68.72	19.23	11.44	4.56	1.28
39	Mandible, cortical bone	127	216	65	112	536	590	169.83	87.11	561.83	11.26	5.78	37.25
40	Mandible, spongiosa	127	215	65	112	537	589	170.79	85.89	559.41	11.32	5.69	37.09

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840 Table A.3. (continued – *newborn female phantom*)

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass						
		Column		Row		Slice		Voxels			Coordinates (cm)			
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z	
41	Pelvis													
	Pelvis, cortical bone	114	232	137	183	226	301	172.50	158.30	268.09	11.44	10.50	17.77	
42	Pelvis, spongiosa	115	231	138	182	228	300	172.50	158.77	268.37	11.44	10.53	17.79	
	Ribs													
43	Ribs, cortical bone	100	246	90	179	379	521	172.41	147.01	452.24	11.43	9.75	29.98	
44	Ribs, spongiosa	100	246	91	179	379	521	172.49	147.19	453.08	11.44	9.76	30.04	
	Scapulae													
45	Scapulae, cortical bone	104	242	145	180	480	529	172.50	163.62	508.04	11.44	10.85	33.68	
46	Scapulae, spongiosa	105	241	145	179	481	529	172.50	162.28	509.14	11.44	10.76	33.76	
	Spine													
47	Cervical spine, cortical bone	150	199	131	179	512	582	172.63	153.88	547.44	11.45	10.20	36.29	
48	Cervical spine, spongiosa	151	201	132	179	512	581	172.70	152.59	549.07	11.45	10.12	36.40	
49	Thoracic spine, cortical bone	154	193	151	185	373	516	172.00	169.89	446.41	11.40	11.26	29.60	
50	Thoracic spine, spongiosa	156	191	152	184	374	515	171.97	168.28	445.28	11.40	11.16	29.52	
51	Lumbar spine, cortical bone	156	189	147	182	297	375	171.99	164.09	336.87	11.40	10.88	22.33	
52	Lumbar spine, spongiosa	157	188	147	182	298	375	171.81	161.17	335.72	11.39	10.69	22.26	
	Sacrum													
53	Sacrum, cortical bone	151	191	154	194	248	296	170.80	172.37	279.01	11.32	11.43	18.50	
54	Sacrum, spongiosa	151	190	154	193	249	296	170.71	170.36	279.10	11.32	11.30	18.50	
	Sternum													
55	Sternum, cortical bone	166	181	72	101	448	505	172.46	86.43	481.21	11.43	5.73	31.90	
56	Sternum, spongiosa	166	181	72	101	448	504	172.58	86.60	481.49	11.44	5.74	31.92	
	Cartilage													
57	Cartilage, head	102	244	37	204	531	713	173.66	118.91	636.74	11.51	7.88	42.22	
58	Cartilage, trunk	99	247	64	195	225	585	172.28	138.89	419.04	11.42	9.21	27.78	
59	Cartilage, arms	36	310	89	152	254	521	172.50	126.70	371.79	11.44	8.40	24.65	
60	Cartilage, legs	12	334	11	165	6	251	172.50	94.07	116.39	11.44	6.24	7.72	
61	Brain	115	232	49	198	562	708	172.69	127.58	651.14	11.45	8.46	43.17	
	Breasts													
62	Breast, left, adipose tissue	206	220	54	59	445	458	212.42	56.25	450.83	14.08	3.73	29.89	
63	Breast, left, glandular tissue	209	217	55	59	447	455	212.39	56.26	450.65	14.08	3.73	29.88	
64	Breast, right, adipose tissue	126	140	54	59	445	458	132.58	56.25	450.83	8.79	3.73	29.89	
65	Breast, right, glandular tissue	129	137	55	59	447	455	132.61	56.26	450.65	8.79	3.73	29.88	
	Eyes													
66	Eye lens, left	193	202	52	56	603	611	197.06	53.24	606.09	13.06	3.53	40.18	
67	Eye bulb, left	184	211	47	80	596	617	197.30	63.66	605.99	13.08	4.22	40.18	
68	Eye lens, right	142	150	54	57	600	609	145.18	55.13	604.00	9.63	3.66	40.05	
69	Eye bulb, right	133	201	50	80	594	617	146.18	64.76	604.63	9.69	4.29	40.09	
	Gallbladder													
70	Gallbladder wall	134	161	89	126	354	384	147.31	106.21	368.50	9.77	7.04	24.43	
71	Gallbladder contents	135	160	90	125	355	383	146.84	105.97	368.40	9.74	7.03	24.43	
	Gastrointestinal tract													
72	Stomach wall	160	231	82	145	345	416	198.16	110.57	377.73	13.14	7.33	25.04	
73	Stomach contents	162	229	83	142	348	413	200.41	109.10	378.49	13.29	7.23	25.09	
74	Small intestine wall	113	241	79	137	255	375	178.44	104.35	310.70	11.83	6.92	20.60	
75	Small intestine contents	116	239	81	135	259	372	178.30	104.44	310.84	11.82	6.92	20.61	
76	Ascending colon wall	95	125	72	116	267	360	108.59	97.67	312.89	7.20	6.48	20.74	
77	Ascending colon contents	97	123	74	114	268	359	109.02	97.66	312.89	7.23	6.47	20.74	

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843 Table A.3. (continued – *newborn female phantom*)

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
78	Transverse colon wall, right	112	176	60	94	286	374	151.96	73.94	339.18	10.08	4.90	22.49
79	Transverse colon content, right	114	175	61	92	288	372	152.02	73.91	339.05	10.08	4.90	22.48
80	Transverse colon wall, left	170	245	58	104	284	381	201.76	75.13	340.02	13.38	4.98	22.54
81	Transverse colon content, left	170	244	59	102	286	380	201.73	75.05	339.93	13.37	4.98	22.54
82	Descending colon wall, left	221	255	80	139	275	362	240.91	112.40	318.65	15.97	7.45	21.13
83	Descending colon content, left	222	253	82	137	276	361	240.51	112.43	318.76	15.95	7.45	21.13
84	Sigmoid colon wall	143	237	120	158	236	301	183.27	139.97	271.31	12.15	9.28	17.99
85	Sigmoid colon content	144	236	121	157	217	300	186.61	138.48	272.19	12.37	9.18	18.05
86	Rectum wall	160	177	141	157	217	235	168.34	148.87	226.44	11.16	9.87	15.01
Heart													
87	Heart wall	149	212	80	136	439	483	180.94	106.55	460.25	12.00	7.06	30.51
88	Heart chamber contents (blood)	155	200	88	126	444	475	178.07	106.99	461.27	11.81	7.09	30.58
Kidneys													
89	Kidney, left, cortex	191	229	129	169	308	374	212.23	150.03	343.36	14.07	9.95	22.76
90	Kidney, left, medulla	195	221	136	160	318	364	209.40	147.28	341.92	13.88	9.76	22.67
91	Kidney, left, pelvis	201	215	144	157	329	353	208.04	150.20	341.64	13.79	9.96	22.65
92	Kidney, right cortex	121	159	125	165	299	365	136.23	145.72	334.47	9.03	9.66	22.18
93	Kidney, right medulla	128	154	131	156	309	355	139.00	143.07	333.27	9.22	9.49	22.10
94	Kidney, right pelvis	135	149	139	153	321	344	140.28	145.99	332.90	9.30	9.68	22.07
95	Liver	95	222	70	167	307	445	141.85	116.83	396.59	9.40	7.75	26.29
Lungs													
96	Lung, left, blood	191	227	107	159	438	499	206.94	141.91	464.19	13.72	9.41	30.78
97	Lung, left, air-filled tissue	182	239	89	172	419	510	209.46	136.52	461.94	13.89	9.05	30.63
98	Lung, right blood	118	155	108	164	439	504	141.72	138.97	463.01	9.40	9.21	30.70
99	Lung, right air-filled tissue	109	177	81	169	427	509	139.44	132.73	465.14	9.25	8.80	30.84
Lymphatic nodes													
100	Lymphatic nodes, ET airways	141	203	85	142	519	591	171.50	115.62	567.47	11.37	7.67	37.62
101	Lymphatic nodes, thoracic airways	143	201	126	173	353	536	172.26	150.02	433.14	11.42	9.95	28.72
102	Lymphatic nodes, head	140	204	109	153	511	565	171.50	138.50	539.33	11.37	9.18	35.76
103	Lymphatic nodes, trunk	81	263	52	188	200	527	171.50	144.79	332.49	11.37	9.60	22.04
104	Lymphatic nodes, arms	47	297	125	156	355	477	171.50	136.05	411.50	11.37	9.02	27.28
105	Lymphatic nodes, legs	36	308	78	114	95	176	171.50	93.41	145.86	11.37	6.19	9.67
Muscle (skeletal)													
106	Muscle, head	109	236	43	202	536	714	172.30	118.98	600.92	11.42	7.89	39.84
107	Muscle, trunk	80	266	42	200	220	552	172.41	121.09	394.06	11.43	8.03	26.13
108	Muscle, arms	37	309	89	170	250	507	172.51	132.21	404.03	11.44	8.77	26.79
109	Muscle, legs	2	344	2	172	3	282	172.42	104.17	152.01	11.43	6.91	10.08
110	Oesophagus wall	169	190	133	151	397	548	175.56	145.34	472.38	11.64	9.64	31.32
Ovaries													
111	Ovary, left	184	193	118	127	269	278	187.76	122.01	272.55	12.45	8.09	18.07
112	Ovary, right	153	162	118	127	269	278	157.24	122.01	272.55	10.42	8.09	18.07
113	Pancreas	173	247	111	143	348	373	215.31	128.16	359.98	14.28	8.50	23.87
114	Pituitary gland	168	175	97	104	619	627	171.08	100.03	622.64	11.34	6.63	41.28
115	Prostate												
Residual tissue													
116	Residual tissue, head	106	240	39	206	534	715	170.72	125.18	635.95	11.32	8.30	42.16
117	Residual tissue, trunk	50	295	39	210	208	552	174.17	126.71	375.04	11.55	8.40	24.86
118	Residual tissue, arms	34	312	88	180	250	512	172.52	133.89	423.64	11.44	8.88	28.09

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846 Table A.3. (continued – *newborn female phantom*)

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
119	Residual tissue, legs	2	344	2	182	2	285	171.92	114.49	186.79	11.40	7.59	12.38
	Salivary glands												
120	Salivary glands, left	175	220	80	132	538	590	198.81	111.62	561.03	13.18	7.40	37.20
121	Salivary glands, right	126	171	80	132	538	590	146.19	111.62	561.03	9.69	7.40	37.20
	Skin												
122	Skin, head	101	245	36	207	534	716	172.42	122.41	628.52	11.43	8.12	41.67
123	Skin, trunk	48	296	38	211	208	552	172.74	125.79	383.36	11.45	8.34	25.42
124	Skin, arms	33	313	87	181	250	497	172.36	127.59	371.62	11.43	8.46	24.64
125	Skin, legs	1	345	1	183	1	258	172.51	96.40	128.43	11.44	6.39	8.51
126	Spinal cord	166	179	147	191	260	560	172.22	168.93	423.95	11.42	11.20	28.11
127	Spleen	197	242	114	159	372	421	224.51	141.16	394.72	14.89	9.36	26.17
128	Teeth												
	Testes												
129	Testis, left												
130	Testis, right												
131	Thymus	150	196	95	134	481	524	173.56	113.64	500.62	11.51	7.53	33.19
132	Thyroid	157	191	115	134	530	554	173.01	122.23	541.33	11.47	8.10	35.89
133	Tongue (inner part)	159	187	78	115	544	571	172.49	99.59	558.34	11.44	6.60	37.02
134	Tonsils	160	185	108	114	563	570	172.09	110.43	566.21	11.41	7.32	37.54
	Ureters												
135	Ureter, left	179	200	120	147	266	336	187.56	132.38	302.65	12.44	8.78	20.07
136	Ureter, right	146	167	120	147	266	336	157.43	132.40	302.70	10.44	8.78	20.07
137	Urinary bladder wall	147	199	87	125	219	264	172.58	105.66	241.46	11.44	7.01	16.01
138	Urinary bladder contents	150	196	89	123	220	261	172.54	105.52	240.24	11.44	7.00	15.93
139	Uterus and cervix	156	187	113	137	228	269	171.86	127.11	251.93	11.39	8.43	16.70
140	Air inside the body	161	188	41	142	472	616	172.47	100.96	550.83	11.44	6.69	36.52

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850 Table A.4. ID listings, rectangular prism (box) containing the organ (minimum/maximum
 851 columns, rows, and slices occupied by each organ/tissue), and organs centres of mass (in terms of
 852 voxels as well as co-ordinates) for the *1-year-old male phantom*.

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
Adrenals													
1	Adrenal gland, left	213	245	169	193	328	344	224.76	182.01	335.40	14.90	12.07	46.96
2	Adrenal gland, right	144	184	172	194	329	343	166.40	182.40	334.10	11.03	12.09	46.77
Airways (and mouth)													
3	Anterior nasal passage (ET ₁)	185	204	5	14	459	465	193.79	9.14	461.37	12.85	0.61	64.59
4	Posterior nasal passage (ET ₂)	186	208	13	127	448	479	196.31	61.72	464.60	13.02	4.09	65.04
5	Oral mucosa, tongue	175	214	53	102	435	453	194.00	77.54	449.73	12.86	5.14	62.96
6	Oral mucosa, lips & cheeks	158	234	18	45	439	451	196.10	28.94	444.89	13.00	1.92	62.28
7	Trachea	190	202	128	150	401	427	195.11	138.77	413.48	12.94	9.20	57.89
8	Bronchi	166	229	139	150	383	400	196.96	144.38	390.43	13.06	9.57	54.66
Blood vessels													
9	Blood vessels, head	99	295	146	180	411	456	196.35	154.82	427.21	13.02	10.26	59.81
10	Blood vessels, trunk	186	208	153	167	328	426	196.75	157.97	383.41	13.04	10.47	53.68
11	Blood vessels, arms	4	390	109	171	247	406	196.50	136.80	326.60	13.03	9.07	45.72
12	Blood vessels, legs	100	294	131	177	28	226	196.50	149.10	127.97	13.03	9.89	17.92
Bones:													
Arm bones:													
13	Humeri, proximal end, cortical bone	55	339	134	165	365	411	196.50	146.41	392.29	13.03	9.71	54.92
14	Humeri, upper half, spongiosa	72	322	137	161	395	410	196.50	148.20	403.21	13.03	9.83	56.45
15	Humeri, upper half, medullary cavity	58	336	143	148	365	396	196.50	144.59	381.16	13.03	9.59	53.36
16	Humeri, lower half, cortical bone	17	377	121	151	312	365	196.50	140.29	335.69	13.03	9.30	47.00
17	Humeri, lower half, spongiosa	21	373	127	148	314	334	196.50	138.53	322.05	13.03	9.18	45.09
18	Humeri, lower half, medullary cavity	39	355	143	147	334	364	196.50	144.52	348.35	13.03	9.58	48.77
19	Ulnae and radii, cortical bone	8	386	98	153	132	320	196.37	125.04	282.00	13.02	8.29	39.48
20	Ulnae and radii, spongiosa	11	383	101	148	240	318	196.50	128.93	291.91	13.03	8.55	40.87
21	Ulnae and radii, medullary cavity	11	383	103	142	250	307	196.50	124.40	280.54	13.03	8.25	39.27
22	Wrists and hand bones, cortical bone	10	384	64	138	194	240	196.50	102.90	221.00	13.03	6.82	30.94
23	Wrists and hand bones, spongiosa	10	384	63	138	193	240	196.50	103.07	223.19	13.03	6.83	31.25
Clavicles													
24	Clavicles, cortical bone	93	301	120	169	404	413	196.50	140.15	408.41	13.03	9.29	57.18
25	Clavicles, spongiosa	93	301	121	168	404	412	196.50	141.91	408.47	13.03	9.41	57.19
Cranium													
26	Cranium, cortical bone	98	292	12	242	448	543	195.73	127.51	495.06	12.98	8.45	69.31
27	Cranium, spongiosa	99	292	13	242	448	543	196.35	124.93	493.49	13.02	8.28	69.09
Leg bones:													
28	Femora proximal end, cortical bone	98	296	128	158	174	232	196.50	143.67	206.90	13.03	9.53	28.97
29	Femora upper half, spongiosa	101	293	132	154	210	231	196.50	143.14	220.86	13.03	9.49	30.92
30	Femora upper half, medullary cavity	111	283	143	148	175	209	196.50	144.63	192.40	13.03	9.59	26.94
31	Femora lower half, cortical bone	110	284	131	167	121	174	196.59	146.18	139.62	13.03	9.69	19.55
32	Femora lower half, spongiosa	114	280	136	159	122	137	196.50	146.77	128.24	13.03	9.73	17.95
33	Femora lower half, medullary cavity	121	273	142	147	137	174	196.50	144.01	152.12	13.03	9.55	21.30
34	Tibiae, fibulae, and patellae, cortical bone	113	281	124	176	22	124	196.50	154.96	79.78	13.03	10.27	11.17
35	Tibiae, fibulae, and patellae, spongiosa	118	276	125	174	22	124	196.50	151.92	100.19	13.03	10.07	14.03
36	Tibiae, fibulae, and patellae, medullary cavity	122	272	150	172	35	106	196.50	154.87	75.73	13.03	10.27	10.60
37	Ankles and foot bones, cortical bone	117	277	53	177	6	27	196.41	126.11	14.45	13.02	8.36	2.02
38	Ankles and foot bones, spongiosa	118	276	55	176	6	27	196.53	138.30	16.16	13.03	9.17	2.26
39	Mandible, cortical bone	139	252	32	119	432	462	194.37	68.96	443.56	12.89	4.57	62.10
40	Mandible, spongiosa	141	251	33	118	432	462	194.79	61.46	441.34	12.91	4.07	61.79

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855 Table A.4. (continued – *1-year-old male phantom*)

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
Pelvis													
41	Pelvis, cortical bone	112	291	117	197	207	271	198.71	154.68	242.92	13.17	10.26	34.01
42	Pelvis, spongiosa	113	289	119	196	207	270	198.45	155.40	242.48	13.16	10.30	33.95
Ribs													
43	Ribs, cortical bone	80	314	69	205	305	418	196.44	162.57	361.33	13.02	10.78	50.59
44	Ribs, spongiosa	81	313	69	205	306	418	196.50	163.57	361.63	13.03	10.84	50.63
Scapulae													
45	Scapulae, cortical bone	87	307	171	218	370	412	196.50	198.59	395.03	13.03	13.17	55.30
46	Scapulae, spongiosa	88	306	172	218	371	412	196.50	194.76	396.62	13.03	12.91	55.53
Spine													
47	Cervical spine, cortical bone	170	224	145	200	417	458	197.54	165.78	436.14	13.10	10.99	61.06
48	Cervical spine, spongiosa	169	224	146	201	417	458	197.49	164.03	436.79	13.09	10.88	61.15
49	Thoracic spine, cortical bone	166	228	160	213	318	420	196.34	187.68	369.46	13.02	12.44	51.72
50	Thoracic spine, spongiosa	166	227	161	213	318	420	196.64	185.47	368.23	13.04	12.30	51.55
51	Lumbar spine, cortical bone	166	226	152	214	265	317	194.57	181.28	290.29	12.90	12.02	40.64
52	Lumbar spine, spongiosa	167	225	153	213	266	317	194.49	175.64	291.24	12.89	11.64	40.77
Sacrum													
53	Sacrum, cortical bone	163	227	149	204	223	262	195.27	176.44	246.55	12.95	11.70	34.52
54	Sacrum, spongiosa	164	226	150	203	223	261	194.83	172.18	247.07	12.92	11.42	34.59
Sternum													
55	Sternum, cortical bone	187	212	68	115	362	402	197.99	90.55	386.53	13.13	6.00	54.11
56	Sternum, spongiosa	187	212	68	115	362	402	198.05	93.37	388.63	13.13	6.19	54.41
Cartilage													
57	Cartilage, head	88	306	2	207	428	542	196.73	108.60	481.29	13.04	7.20	67.38
58	Cartilage, trunk	86	308	58	184	262	448	196.28	108.90	350.25	13.01	7.22	49.04
59	Cartilage, arms												
60	Cartilage, legs												
61	Brain	106	285	22	233	459	540	195.31	137.53	500.11	12.95	9.12	70.02
Breasts													
62	Breast, left, adipose tissue	249	278	30	41	350	364	263.24	35.34	356.50	17.45	2.34	49.91
63	Breast, left, glandular tissue	254	273	32	39	353	362	263.06	35.14	356.59	17.44	2.33	49.92
64	Breast, right, adipose tissue	116	145	30	41	350	364	129.76	35.34	356.50	8.60	2.34	49.91
65	Breast, right, glandular tissue	121	140	32	39	353	362	129.94	35.14	356.59	8.61	2.33	49.92
Eyes													
66	Eye lens, left	225	235	21	25	475	479	229.13	22.31	476.63	15.19	1.48	66.73
67	Eye bulb, left	217	243	20	47	471	484	229.49	33.34	476.66	15.22	2.21	66.73
68	Eye lens, right	159	169	21	25	475	479	163.87	22.31	476.63	10.86	1.48	66.73
69	Eye bulb, right	151	177	20	47	471	484	163.51	33.34	476.66	10.84	2.21	66.73
Gallbladder													
70	Gallbladder wall	138	186	86	151	294	321	158.77	117.90	307.11	10.53	7.82	43.00
71	Gallbladder contents	139	185	87	150	295	320	157.89	116.56	306.71	10.47	7.73	42.94
Gastrointestinal tract													
72	Stomach wall	189	280	77	159	295	351	235.32	117.42	320.71	15.60	7.78	44.90
73	Stomach contents	190	278	80	158	297	345	241.99	120.80	322.75	16.04	8.01	45.19
74	Small intestine wall	108	283	80	167	231	303	198.86	112.34	266.40	13.18	7.45	37.30
75	Small intestine contents	112	279	84	163	232	300	198.90	112.32	266.44	13.19	7.45	37.30
76	Ascending colon wall	104	151	67	127	235	289	123.24	101.58	261.34	8.17	6.73	36.59
77	Ascending colon contents	108	147	72	123	236	288	123.46	101.57	261.43	8.19	6.73	36.60

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858 Table A.4. (continued – *1-year-old male phantom*)

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
78	Transverse colon wall, right	127	207	56	92	250	296	172.37	73.58	275.96	11.43	4.88	38.63
79	Transverse colon content, right	129	206	60	88	252	294	172.47	73.64	275.89	11.43	4.88	38.62
80	Transverse colon wall, left	195	271	56	109	250	301	228.20	76.66	278.76	15.13	5.08	39.03
81	Transverse colon content, left	199	269	59	106	252	299	228.22	76.99	278.52	15.13	5.10	38.99
82	Descending colon wall, left	229	289	88	151	243	298	265.38	122.88	270.17	17.59	8.15	37.82
83	Descending colon content, left	232	286	91	147	245	297	265.05	122.98	270.30	17.57	8.15	37.84
84	Sigmoid colon wall	157	246	130	191	214	250	198.52	162.00	233.14	13.16	10.74	32.64
85	Sigmoid colon content	160	245	132	189	207	249	199.28	159.76	234.23	13.21	10.59	32.79
86	Rectum wall	170	203	178	191	207	219	187.85	184.15	212.83	12.45	12.21	29.80
Heart													
87	Heart wall	158	251	69	151	346	385	205.35	108.27	365.87	13.61	7.18	51.22
88	Heart chamber contents (blood)	168	244	77	147	349	381	206.44	110.08	364.92	13.69	7.30	51.09
Kidneys													
89	Kidney, left, cortex	214	273	144	194	283	331	246.69	169.16	307.01	16.36	11.22	42.98
90	Kidney, left, medulla	219	259	151	184	293	324	239.72	167.42	308.59	15.89	11.10	43.20
91	Kidney, left, pelvis	223	244	156	174	299	316	233.50	164.78	307.30	15.48	10.93	43.02
92	Kidney, right cortex	127	182	142	194	281	330	152.93	168.55	303.63	10.14	11.18	42.51
93	Kidney, right medulla	140	177	148	184	290	321	157.28	166.28	304.79	10.43	11.02	42.67
94	Kidney, right pelvis	153	173	154	173	296	314	162.43	163.29	304.30	10.77	10.83	42.60
95	Liver	88	263	57	193	279	350	150.05	116.04	324.70	9.95	7.69	45.46
Lungs													
96	Lung, left, blood	225	284	99	181	359	400	249.29	157.44	376.07	16.53	10.44	52.65
97	Lung, left, air-filled tissue	213	301	69	195	339	410	256.21	145.75	369.95	16.99	9.66	51.79
98	Lung, right blood	107	168	102	180	360	402	149.35	145.31	375.06	9.90	9.63	52.51
99	Lung, right air-filled tissue	95	193	67	197	342	412	143.16	142.54	370.95	9.49	9.45	51.93
Lymphatic nodes													
100	Lymphatic nodes, ET always	158	234	54	126	403	478	195.50	91.43	450.13	12.96	6.06	63.02
101	Lymphatic nodes, thoracic airways	162	230	102	166	305	425	195.50	134.42	346.60	12.96	8.91	48.52
102	Lymphatic nodes, head	158	234	103	151	407	458	195.50	127.32	426.87	12.96	8.44	59.76
103	Lymphatic nodes, trunk	65	327	19	179	175	410	195.50	115.48	276.38	12.96	7.66	38.69
104	Lymphatic nodes, arms	11	381	116	146	271	347	195.50	127.47	319.76	12.96	8.45	44.77
105	Lymphatic nodes, legs	113	279	123	142	96	170	195.50	132.78	128.91	12.96	8.80	18.05
Muscle (skeletal)													
106	Muscle, head	103	288	10	243	429	544	196.68	118.06	465.37	13.04	7.83	65.15
107	Muscle, trunk	69	325	23	220	132	432	196.96	109.28	320.93	13.06	7.25	44.93
108	Muscle, arms	3	391	60	163	191	411	196.51	128.90	303.99	13.03	8.55	42.56
109	Muscle, legs	98	296	39	185	2	240	196.50	144.20	125.92	13.03	9.56	17.63
110	Oesophagus wall	191	206	136	164	347	443	196.63	152.62	394.79	13.04	10.12	55.27
Ovaries													
111	Ovary, left												
112	Ovary, right												
113	Pancreas	187	297	104	150	292	310	250.94	129.05	300.18	16.64	8.56	42.03
114	Pituitary gland	193	201	95	104	478	482	196.48	98.79	479.75	13.03	6.55	67.16
115	Prostate	187	209	136	150	208	217	196.89	142.51	212.49	13.05	9.45	29.75
Residual tissue													
116	Residual tissue, head	97	297	9	247	427	545	201.40	133.21	488.03	13.35	8.83	68.32
117	Residual tissue, trunk	59	337	5	247	22	433	199.64	134.65	312.74	13.24	8.93	43.78
118	Residual tissue, arms	2	392	59	184	191	414	196.45	136.07	335.84	13.02	9.02	47.02

859

860

861 Table A.4. (continued – *1-year-old male phantom*)

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
119	Residual tissue, legs	67	327	38	214	2	240	196.47	148.29	166.84	13.03	9.83	23.36
	Salivary glands												
120	Salivary glands, left	195	256	52	142	429	461	227.63	103.29	441.87	15.09	6.85	61.86
121	Salivary glands, right	133	250	52	162	429	540	160.26	103.27	441.89	10.63	6.85	61.87
	Skin												
122	Skin, head	87	307	1	248	427	546	196.55	128.23	486.45	13.03	8.50	68.10
123	Skin, trunk	58	338	4	248	22	431	197.72	133.83	313.80	13.11	8.87	43.93
124	Skin, arms	1	393	58	184	191	414	196.86	126.19	295.10	13.05	8.37	41.31
125	Skin, legs	66	328	37	215	1	227	196.35	145.12	118.50	13.02	9.62	16.59
126	Spinal cord	187	205	159	208	224	450	195.85	186.88	344.52	12.98	12.39	48.23
127	Spleen	247	306	104	186	314	343	285.25	148.66	330.41	18.91	9.86	46.26
128	Teeth												
	Testes												
129	Testis, left	199	213	85	99	197	206	205.24	91.87	201.01	13.61	6.09	28.14
130	Testis, right	181	195	85	99	197	206	187.54	91.86	200.91	12.43	6.09	28.13
131	Thymus	172	227	93	139	384	411	199.36	121.74	394.57	13.22	8.07	55.24
132	Thyroid	177	215	125	146	410	422	195.64	132.92	415.52	12.97	8.81	58.17
133	Tongue (inner part)	175	214	52	102	434	452	193.96	80.91	443.36	12.86	5.36	62.07
134	Tonsils	174	215	90	100	448	453	193.86	94.30	449.92	12.85	6.25	62.99
	Ureters												
135	Ureter, left	206	226	130	163	239	303	214.61	148.23	270.99	14.23	9.83	37.94
136	Ureter, right	168	188	130	163	239	303	178.37	148.24	271.00	11.83	9.83	37.94
137	Urinary bladder wall	165	230	109	162	218	239	196.81	136.45	227.85	13.05	9.05	31.90
138	Urinary bladder contents	169	225	114	156	220	237	196.66	135.61	227.90	13.04	8.99	31.91
139	Uterus and cervix												
140	Air inside the body	166	265	6	151	346	478	207.96	90.96	417.13	13.79	6.03	58.40

862

863

864 Table A.5. ID listings, rectangular prism (box) containing the organ (minimum/maximum
 865 columns, rows, and slices occupied by each organ/tissue), and organs centres of mass (in terms of
 866 voxels as well as co-ordinates) for the *1-year-old female phantom*.

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
Adrenals													
1	Adrenal gland, left	213	245	169	193	328	344	224.76	182.01	335.40	14.90	12.07	46.96
2	Adrenal gland, right	144	184	172	194	329	343	166.40	182.40	334.10	11.03	12.09	46.77
Airways (and mouth)													
3	Anterior nasal passage (ET ₁)	185	204	5	14	459	465	193.79	9.14	461.37	12.85	0.61	64.59
4	Posterior nasal passage (ET ₂)	186	208	13	127	448	479	196.31	61.72	464.60	13.02	4.09	65.04
5	Oral mucosa, tongue	175	214	53	102	435	453	194.00	77.54	449.73	12.86	5.14	62.96
6	Oral mucosa, lips & cheeks	158	234	18	45	439	451	196.10	28.94	444.89	13.00	1.92	62.28
7	Trachea	190	202	128	150	401	427	195.11	138.77	413.48	12.94	9.20	57.89
8	Bronchi	166	229	139	150	383	400	196.96	144.38	390.43	13.06	9.57	54.66
Blood vessels													
9	Blood vessels, head	99	295	146	180	411	456	196.35	154.82	427.21	13.02	10.26	59.81
10	Blood vessels, trunk	186	208	153	167	328	426	196.75	157.97	383.41	13.04	10.47	53.68
11	Blood vessels, arms	4	390	109	171	247	406	196.50	136.80	326.60	13.03	9.07	45.72
12	Blood vessels, legs	100	294	131	177	28	226	196.50	149.10	127.97	13.03	9.89	17.92
Bones:													
Arm bones:													
13	Humeri, proximal end, cortical bone	55	339	134	165	365	411	196.50	146.41	392.29	13.03	9.71	54.92
14	Humeri, upper half, spongiosa	72	322	133	161	21	410	196.52	148.12	401.27	13.03	9.82	56.18
15	Humeri, upper half, medullary cavity	58	336	143	148	365	396	196.50	144.59	381.16	13.03	9.59	53.36
16	Humeri, lower half, cortical bone	17	377	121	151	312	365	196.50	140.29	335.69	13.03	9.30	47.00
17	Humeri, lower half, spongiosa	21	373	127	148	314	334	196.50	138.53	322.05	13.03	9.18	45.09
18	Humeri, lower half, medullary cavity	39	355	143	147	334	364	196.50	144.52	348.35	13.03	9.58	48.77
19	Ulnae and radii, cortical bone	8	386	98	152	132	320	196.37	125.04	282.04	13.02	8.29	39.49
20	Ulnae and radii, spongiosa	11	383	101	148	240	318	196.50	128.93	291.91	13.03	8.55	40.87
21	Ulnae and radii, medullary cavity	11	383	103	142	250	307	196.50	124.40	280.54	13.03	8.25	39.27
22	Wrists and hand bones, cortical bone	10	384	64	138	194	240	196.50	102.90	221.00	13.03	6.82	30.94
23	Wrists and hand bones, spongiosa	10	384	63	138	193	240	196.50	103.07	223.19	13.03	6.83	31.25
Clavicles													
24	Clavicles, cortical bone	93	301	120	169	404	413	196.50	140.15	408.41	13.03	9.29	57.18
25	Clavicles, spongiosa	93	301	121	168	404	412	196.50	141.91	408.47	13.03	9.41	57.19
Cranium													
26	Cranium, cortical bone	98	292	12	242	448	543	195.73	127.51	495.06	12.98	8.45	69.31
27	Cranium, spongiosa	99	292	13	242	448	543	196.35	124.93	493.49	13.02	8.28	69.09
Leg bones:													
28	Femora proximal end, cortical bone	98	296	128	158	174	232	196.50	143.67	206.90	13.03	9.53	28.97
29	Femora upper half, spongiosa	101	293	132	154	210	231	196.50	143.14	220.86	13.03	9.49	30.92
30	Femora upper half, medullary cavity	111	283	143	148	175	209	196.50	144.63	192.40	13.03	9.59	26.94
31	Femora lower half, cortical bone	110	284	131	167	121	174	196.59	146.18	139.62	13.03	9.69	19.55
32	Femora lower half, spongiosa	114	280	136	159	122	137	196.51	146.77	128.24	13.03	9.73	17.95
33	Femora lower half, medullary cavity	121	273	142	147	137	174	196.50	144.01	152.12	13.03	9.55	21.30
34	Tibiae, fibulae, and patellae, cortical bone	113	281	124	176	22	124	196.50	154.96	79.78	13.03	10.27	11.17
35	Tibiae, fibulae, and patellae, spongiosa	118	276	125	174	22	124	196.50	151.92	100.19	13.03	10.07	14.03
36	Tibiae, fibulae, and patellae, medullary cavity	122	272	150	172	35	106	196.50	154.87	75.73	13.03	10.27	10.60
37	Ankles and foot bones, cortical bone	117	277	53	177	6	27	196.43	126.11	14.45	13.02	8.36	2.02
38	Ankles and foot bones, spongiosa	118	276	55	176	6	27	196.52	138.30	16.15	13.03	9.17	2.26
39	Mandible, cortical bone	139	252	32	119	432	462	194.37	68.96	443.56	12.89	4.57	62.10
40	Mandible, spongiosa	141	251	33	118	432	462	194.79	61.46	441.34	12.91	4.07	61.79

867
868

869 Table A.5. (continued – *1-year-old female phantom*)

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
Pelvis													
41	Pelvis, cortical bone	112	291	117	197	207	271	198.71	154.68	242.92	13.17	10.26	34.01
42	Pelvis, spongiosa	113	289	119	196	207	270	198.45	155.40	242.48	13.16	10.30	33.95
Ribs													
43	Ribs, cortical bone	80	314	69	205	305	418	196.44	162.57	361.33	13.02	10.78	50.59
44	Ribs, spongiosa	81	313	69	205	306	418	196.50	163.57	361.63	13.03	10.84	50.63
Scapulae													
45	Scapulae, cortical bone	87	307	171	218	370	412	196.50	198.59	395.03	13.03	13.17	55.30
46	Scapulae, spongiosa	88	306	172	218	371	412	196.50	194.76	396.62	13.03	12.91	55.53
Spine													
47	Cervical spine, cortical bone	170	224	145	200	417	458	197.54	165.78	436.14	13.10	10.99	61.06
48	Cervical spine, spongiosa	169	224	146	201	417	458	197.49	164.03	436.79	13.09	10.88	61.15
49	Thoracic spine, cortical bone	166	228	160	213	318	420	196.34	187.68	369.46	13.02	12.44	51.72
50	Thoracic spine, spongiosa	166	227	161	213	318	420	196.64	185.47	368.23	13.04	12.30	51.55
51	Lumbar spine, cortical bone	166	226	152	214	265	317	194.57	181.28	290.29	12.90	12.02	40.64
52	Lumbar spine, spongiosa	167	225	153	213	266	317	194.49	175.64	291.24	12.89	11.64	40.77
Sacrum													
53	Sacrum, cortical bone	163	227	149	204	223	262	195.27	176.44	246.55	12.95	11.70	34.52
54	Sacrum, spongiosa	164	226	150	203	223	261	194.83	172.18	247.07	12.92	11.42	34.59
Sternum													
55	Sternum, cortical bone	187	212	68	115	362	402	197.99	90.55	386.53	13.13	6.00	54.11
56	Sternum, spongiosa	187	212	68	115	362	402	198.05	93.37	388.63	13.13	6.19	54.41
Cartilage													
57	Cartilage, head	88	306	2	207	428	542	196.73	108.60	481.29	13.04	7.20	67.38
58	Cartilage, trunk	86	308	58	184	262	448	196.28	108.90	350.25	13.01	7.22	49.04
59	Cartilage, arms												
60	Cartilage, legs												
61	Brain	106	285	22	233	459	540	195.31	137.53	500.11	12.95	9.12	70.02
Breasts													
62	Breast, left, adipose tissue	249	278	30	41	350	364	263.24	35.34	356.50	17.45	2.34	49.91
63	Breast, left, glandular tissue	254	273	32	39	353	362	263.06	35.14	356.59	17.44	2.33	49.92
64	Breast, right, adipose tissue	116	145	30	41	350	364	129.76	35.34	356.50	8.60	2.34	49.91
65	Breast, right, glandular tissue	121	140	32	39	353	362	129.94	35.14	356.59	8.61	2.33	49.92
Eyes													
66	Eye lens, left	225	235	21	25	475	479	229.13	22.31	476.63	15.19	1.48	66.73
67	Eye bulb, left	217	243	20	47	471	484	229.49	33.34	476.66	15.22	2.21	66.73
68	Eye lens, right	159	169	21	25	475	479	163.87	22.31	476.63	10.86	1.48	66.73
69	Eye bulb, right	151	177	20	47	471	484	163.51	33.34	476.66	10.84	2.21	66.73
Gallbladder													
70	Gallbladder wall	138	186	86	151	294	321	158.77	117.90	307.11	10.53	7.82	43.00
71	Gallbladder contents	139	185	87	150	295	320	157.89	116.56	306.71	10.47	7.73	42.94
Gastrointestinal tract													
72	Stomach wall	189	280	77	159	295	351	235.33	117.41	320.71	15.60	7.78	44.90
73	Stomach contents	190	278	80	158	297	345	241.99	120.80	322.75	16.04	8.01	45.19
74	Small intestine wall	108	283	80	167	231	303	198.87	112.27	266.37	13.18	7.44	37.29
75	Small intestine contents	112	279	84	163	234	300	198.90	112.43	266.51	13.19	7.45	37.31
76	Ascending colon wall	104	151	67	127	235	289	123.26	101.60	261.32	8.17	6.74	36.58
77	Ascending colon contents	108	147	72	123	236	288	123.46	101.57	261.43	8.19	6.73	36.60

870

871 Table A.5. (continued – *1-year-old female phantom*)

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
78	Transverse colon wall, right	127	207	56	92	250	296	172.37	73.58	275.96	11.43	4.88	38.63
79	Transverse colon content, right	129	206	60	88	252	294	172.47	73.64	275.89	11.43	4.88	38.62
80	Transverse colon wall, left	195	271	56	109	250	301	228.20	76.66	278.76	15.13	5.08	39.03
81	Transverse colon content, left	199	269	59	106	252	299	228.22	76.99	278.52	15.13	5.10	38.99
82	Descending colon wall, left	229	289	88	151	243	298	265.52	122.88	270.25	17.60	8.15	37.83
83	Descending colon content, left	232	286	91	148	245	297	265.02	123.00	270.27	17.57	8.15	37.84
84	Sigmoid colon wall	157	246	130	191	214	250	198.55	162.00	233.15	13.16	10.74	32.64
85	Sigmoid colon content	160	245	132	189	207	249	199.24	159.78	234.22	13.21	10.59	32.79
86	Rectum wall	170	203	178	191	207	219	187.85	184.15	212.83	12.45	12.21	29.80
Heart													
87	Heart wall	158	251	69	151	346	385	205.35	108.27	365.87	13.61	7.18	51.22
88	Heart chamber contents (blood)	168	244	77	147	349	381	206.44	110.08	364.92	13.69	7.30	51.09
Kidneys													
89	Kidney, left, cortex	214	273	144	194	283	331	246.69	169.16	307.01	16.36	11.22	42.98
90	Kidney, left, medulla	219	259	151	184	293	324	239.72	167.42	308.59	15.89	11.10	43.20
91	Kidney, left, pelvis	223	244	156	174	299	316	233.50	164.78	307.30	15.48	10.93	43.02
92	Kidney, right cortex	127	182	142	194	281	330	152.93	168.55	303.63	10.14	11.18	42.51
93	Kidney, right medulla	140	177	148	184	290	321	157.28	166.28	304.79	10.43	11.02	42.67
94	Kidney, right pelvis	153	173	154	173	296	314	162.43	163.29	304.30	10.77	10.83	42.60
95	Liver	88	263	57	193	279	350	150.05	116.04	324.70	9.95	7.69	45.46
Lungs													
96	Lung, left, blood	225	284	99	181	359	400	249.29	157.44	376.07	16.53	10.44	52.65
97	Lung, left, air-filled tissue	213	301	69	195	339	410	256.21	145.75	369.95	16.99	9.66	51.79
98	Lung, right blood	107	168	102	180	360	402	149.35	145.31	375.06	9.90	9.63	52.51
99	Lung, right air-filled tissue	95	193	67	197	342	412	143.16	142.54	370.95	9.49	9.45	51.93
Lymphatic nodes													
100	Lymphatic nodes, ET airways	160	232	52	127	406	482	195.50	91.31	450.50	12.96	6.05	63.07
101	Lymphatic nodes, thoracic airways	166	226	108	165	292	429	195.50	134.28	346.76	12.96	8.90	48.55
102	Lymphatic nodes, head	156	236	94	147	409	458	195.50	119.02	422.80	12.96	7.89	59.19
103	Lymphatic nodes, trunk	58	334	21	180	173	411	195.50	115.76	275.53	12.96	7.67	38.57
104	Lymphatic nodes, arms	18	374	116	145	279	350	195.50	127.32	320.24	12.96	8.44	44.83
105	Lymphatic nodes, legs	115	277	123	144	98	168	195.50	132.68	129.81	12.96	8.80	18.17
Muscle (skeletal)													
106	Muscle, head	103	288	10	243	429	544	196.68	118.05	465.41	13.04	7.83	65.16
107	Muscle, trunk	69	325	23	220	132	432	196.95	109.56	322.11	13.06	7.26	45.10
108	Muscle, arms	3	391	60	163	191	411	196.51	128.89	303.96	13.03	8.55	42.56
109	Muscle, legs	98	296	39	185	2	240	196.50	144.20	125.90	13.03	9.56	17.63
110	Oesophagus wall	191	206	136	164	347	443	196.63	152.58	394.91	13.04	10.12	55.29
Ovaries													
111	Ovary, left	220	238	124	133	237	241	228.27	127.89	238.52	15.13	8.48	33.39
112	Ovary, right	154	172	124	133	236	241	162.37	127.89	238.10	10.77	8.48	33.33
113	Pancreas	187	297	104	150	292	310	250.94	129.05	300.18	16.64	8.56	42.03
114	Pituitary gland	193	201	95	104	478	482	196.48	98.79	479.75	13.03	6.55	67.16
115	Prostate												
Residual tissue													
116	Residual tissue, head	97	297	9	247	427	545	201.43	133.32	488.00	13.35	8.84	68.32
117	Residual tissue, trunk	59	337	5	247	22	433	199.64	134.66	312.79	13.24	8.93	43.79
118	Residual tissue, arms	2	392	59	184	191	414	196.45	136.08	335.81	13.02	9.02	47.01

872

873

874 Table A.5. (continued – *1-year-old female phantom*)

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
119	Residual tissue, legs	67	327	38	214	2	240	196.48	148.31	166.88	13.03	9.83	23.36
	Salivary glands												
120	Salivary glands, left	195	256	52	142	429	461	227.63	103.29	441.87	15.09	6.85	61.86
121	Salivary glands, right	133	249	52	162	429	540	160.26	103.27	441.89	10.63	6.85	61.86
	Skin												
122	Skin, head	87	307	1	248	427	546	196.55	128.23	486.45	13.03	8.50	68.10
123	Skin, trunk	58	338	4	248	203	431	197.73	134.37	315.12	13.11	8.91	44.12
124	Skin, arms	1	393	58	184	191	414	196.86	126.20	295.13	13.05	8.37	41.32
125	Skin, legs	66	328	37	215	1	227	196.35	145.12	118.49	13.02	9.62	16.59
126	Spinal cord	187	205	159	208	224	450	195.85	186.88	344.53	12.98	12.39	48.23
127	Spleen	247	306	104	186	314	343	285.25	148.66	330.41	18.91	9.86	46.26
128	Teeth												
	Testes												
129	Testis, left												
130	Testis, right												
131	Thymus	172	227	93	139	384	411	199.36	121.74	394.57	13.22	8.07	55.24
132	Thyroid	177	215	125	146	410	422	195.64	132.92	415.52	12.97	8.81	58.17
133	Tongue (inner part)	175	214	52	102	434	452	193.96	80.91	443.36	12.86	5.36	62.07
134	Tonsils	174	215	90	100	448	453	193.83	94.29	449.92	12.85	6.25	62.99
	Ureters												
135	Ureter, left	206	226	130	163	239	303	214.61	148.23	270.99	14.23	9.83	37.94
136	Ureter, right	168	188	130	163	239	303	178.37	148.24	271.00	11.83	9.83	37.94
137	Urinary bladder wall	165	230	109	159	216	239	196.83	133.82	227.52	13.05	8.87	31.85
138	Urinary bladder contents	170	225	112	154	219	236	196.69	133.60	227.33	13.04	8.86	31.83
139	Uterus and cervix	174	215	138	156	227	237	194.76	146.83	232.38	12.91	9.73	32.53
140	Air inside the body	166	265	6	151	346	478	207.96	90.96	417.12	13.79	6.03	58.40

875

876

877 Table A.6. ID listings, rectangular prism (box) containing the organ (minimum/maximum
 878 columns, rows, and slices occupied by each organ/tissue), and organs centres of mass (in terms of
 879 voxels as well as co-ordinates) for the *5-year-old male phantom*.

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
Adrenals													
1	Adrenal gland, left	227	253	160	179	374	387	236.33	169.73	379.83	20.09	14.43	73.23
2	Adrenal gland, right	161	190	160	180	371	384	177.81	169.54	375.74	15.11	14.41	72.44
Airways (and mouth)													
3	Anterior nasal passage (ET ₁)	204	222	6	18	504	514	212.47	12.05	505.80	18.06	1.02	97.52
4	Posterior nasal passage (ET ₂)	171	252	17	119	479	529	209.85	68.36	506.73	17.84	5.81	97.70
5	Oral mucosa, tongue	194	226	51	103	485	494	209.47	75.43	492.35	17.80	6.41	94.93
6	Oral mucosa, lips & cheeks	180	241	21	38	486	495	209.39	27.40	489.92	17.80	2.33	94.46
7	Trachea	205	215	109	130	442	461	209.37	119.34	450.81	17.80	10.14	86.92
8	Bronchi	184	236	120	131	430	441	209.49	125.56	433.66	17.81	10.67	83.61
Blood vessels													
9	Blood vessels, head	105	315	133	169	450	494	209.48	148.29	467.16	17.81	12.60	90.07
10	Blood vessels, trunk	189	229	117	152	375	466	209.06	131.29	424.43	17.77	11.16	81.83
11	Blood vessels, arms	11	409	112	173	275	447	209.50	131.33	360.65	17.81	11.16	69.53
12	Blood vessels, legs	119	301	124	178	31	271	209.50	143.04	150.71	17.81	12.16	29.06
Bones:													
Arm bones:													
13	Humeri, proximal end, cortical bone	51	369	135	164	402	452	209.50	147.04	431.79	17.81	12.50	83.25
14	Humeri, upper half, spongiosa	61	359	137	161	434	452	209.50	148.45	443.20	17.81	12.62	85.45
15	Humeri, upper half, medullary cavity	54	366	141	150	402	434	209.50	144.23	418.99	17.81	12.26	80.78
16	Humeri, lower half, cortical bone	22	398	121	149	345	402	209.50	138.41	370.72	17.81	11.76	71.47
17	Humeri, lower half, spongiosa	25	395	124	143	346	368	209.50	134.23	355.30	17.81	11.41	68.50
18	Humeri, lower half, medullary cavity	42	378	138	146	368	402	209.50	142.18	384.32	17.81	12.08	74.10
19	Ulnae and radii, cortical bone	11	409	100	147	268	355	208.21	125.92	314.46	17.70	10.70	60.63
20	Ulnae and radii, spongiosa	13	407	102	145	269	355	209.50	127.93	322.22	17.81	10.87	62.12
21	Ulnae and radii, medullary cavity	16	404	108	141	282	338	209.38	125.37	312.10	17.80	10.66	60.17
22	Wrists and hand bones, cortical bone	7	413	72	138	213	269	209.50	107.23	245.50	17.81	9.11	47.33
23	Wrists and hand bones, spongiosa	8	412	72	137	214	269	209.50	106.82	249.50	17.81	9.08	48.10
Clavicles													
24	Clavicles, cortical bone	88	332	93	149	449	455	209.50	118.18	451.73	17.81	10.05	87.09
25	Clavicles, spongiosa	89	331	94	148	449	455	209.50	116.71	451.57	17.81	9.92	87.06
Cranium													
26	Cranium, cortical bone	128	291	17	224	491	569	210.04	120.96	527.18	17.85	10.28	101.64
27	Cranium, spongiosa	129	290	17	223	491	568	210.33	126.11	532.27	17.88	10.72	102.62
Leg bones:													
28	Femora proximal end, cortical bone	106	314	127	158	195	282	209.50	144.09	244.42	17.81	12.25	47.13
29	Femora upper half, spongiosa	109	311	130	154	255	281	209.50	140.81	267.73	17.81	11.97	51.62
30	Femora upper half, medullary cavity	119	301	143	151	195	254	209.50	146.18	224.82	17.81	12.43	43.34
31	Femora lower half, cortical bone	127	293	134	173	144	194	209.50	150.88	162.43	17.81	12.82	31.32
32	Femora lower half, spongiosa	130	290	138	167	145	163	209.50	151.32	152.88	17.81	12.86	29.48
33	Femora lower half, medullary cavity	136	284	143	151	164	194	209.50	147.00	176.71	17.81	12.50	34.07
34	Tibiae, fibulae, and patellae, cortical bone	127	293	123	171	26	158	209.48	151.24	95.01	17.81	12.86	18.32
35	Tibiae, fibulae, and patellae, spongiosa	131	289	124	169	26	157	209.50	146.55	119.01	17.81	12.46	22.94
36	Tibiae, fibulae, and patellae, medullary cavity	135	285	144	167	46	123	209.65	150.68	86.61	17.82	12.81	16.70
37	Ankles and foot bones, cortical bone	122	298	33	183	4	30	209.50	120.48	14.86	17.81	10.24	2.87
38	Ankles and foot bones, spongiosa	123	297	34	182	4	29	209.50	135.49	16.47	17.81	11.52	3.18
39	Mandible, cortical bone	153	270	26	111	479	508	211.98	70.45	488.96	18.02	5.99	94.27
40	Mandible, spongiosa	154	269	26	110	479	507	211.28	66.41	486.93	17.96	5.64	93.88

880
881

882 Table A.6. (continued – 5-year-old male phantom)

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
Pelvis													
41	Pelvis, cortical bone	96	324	110	188	255	319	209.50	145.81	290.18	17.81	12.39	55.95
42	Pelvis, spongiosa	97	323	112	187	256	318	209.50	147.00	288.88	17.81	12.50	55.70
Ribs													
43	Ribs, cortical bone	90	330	59	197	345	465	209.59	145.18	408.81	17.82	12.34	78.82
44	Ribs, spongiosa	91	329	60	197	345	465	209.51	143.87	410.09	17.81	12.23	79.06
Scapulae													
45	Scapulae, cortical bone	75	345	147	204	409	452	209.50	183.15	435.11	17.81	15.57	83.89
46	Scapulae, spongiosa	76	344	148	203	410	452	209.50	178.23	437.42	17.81	15.15	84.33
Spine													
47	Cervical spine, cortical bone	183	239	126	174	464	493	208.86	142.42	478.25	17.75	12.11	92.21
48	Cervical spine, spongiosa	183	238	127	173	464	493	208.91	141.09	478.46	17.76	11.99	92.25
49	Thoracic spine, cortical bone	182	233	131	192	366	465	207.65	163.75	416.61	17.65	13.92	80.32
50	Thoracic spine, spongiosa	184	232	132	192	366	465	207.59	161.70	416.68	17.65	13.74	80.34
51	Lumbar spine, cortical bone	184	239	122	189	314	367	209.18	152.08	340.76	17.78	12.93	65.70
52	Lumbar spine, spongiosa	187	241	122	188	314	367	209.49	146.17	339.45	17.81	12.42	65.45
Sacrum													
53	Sacrum, cortical bone	172	250	139	201	281	317	209.19	170.35	302.60	17.78	14.48	58.34
54	Sacrum, spongiosa	172	249	140	201	282	317	209.58	162.59	304.90	17.81	13.82	58.79
Sternum													
55	Sternum, cortical bone	191	227	56	91	410	450	209.25	72.73	432.04	17.79	6.18	83.30
56	Sternum, spongiosa	192	228	57	91	410	449	208.96	73.44	433.03	17.76	6.24	83.49
Cartilage													
57	Cartilage, head	112	308	2	150	461	520	210.09	94.67	492.56	17.86	8.05	94.97
58	Cartilage, trunk	112	308	53	164	311	484	209.10	111.64	386.93	17.77	9.49	74.60
59	Cartilage, arms												
60	Cartilage, legs												
61	Brain	135	284	36	216	491	564	209.81	134.15	531.42	17.83	11.40	102.46
Breasts													
62	Breast, left, adipose tissue	265	296	39	51	396	408	280.24	44.65	401.84	23.82	3.80	77.47
63	Breast, left, glandular tissue	271	291	41	50	398	406	280.13	44.94	401.70	23.81	3.82	77.45
64	Breast, right, adipose tissue	124	155	39	51	396	408	138.76	44.65	401.84	11.79	3.80	77.47
65	Breast, right, glandular tissue	129	149	41	50	398	406	138.88	44.94	401.70	11.80	3.82	77.45
Eyes													
66	Eye lens, left	237	246	34	37	517	521	240.90	34.83	518.47	20.48	2.96	99.96
67	Eye bulb, left	228	254	32	56	514	524	240.63	44.04	518.77	20.45	3.74	100.02
68	Eye lens, right	174	183	34	37	517	521	178.10	34.83	518.47	15.14	2.96	99.96
69	Eye bulb, right	166	192	32	56	514	524	178.37	44.04	518.77	15.16	3.74	100.02
Gallbladder													
70	Gallbladder wall	150	185	85	145	349	369	167.42	114.49	357.78	14.23	9.73	68.98
71	Gallbladder contents	150	185	86	144	349	368	167.19	109.80	357.35	14.21	9.33	68.90
Gastrointestinal tract													
72	Stomach wall	221	305	62	148	351	394	268.46	104.81	372.43	22.82	8.91	71.80
73	Stomach contents	225	299	66	145	353	386	268.95	105.82	371.76	22.86	8.99	71.68
74	Small intestine wall	124	299	71	160	257	358	205.11	101.26	319.84	17.43	8.61	61.66
75	Small intestine contents	129	294	76	132	293	354	205.52	101.42	320.03	17.47	8.62	61.70
76	Ascending colon wall	114	157	64	145	285	346	132.69	116.10	319.49	11.28	9.87	61.60
77	Ascending colon contents	119	155	69	140	287	344	132.98	115.80	319.70	11.30	9.84	61.64

883

884 Table A.6. (continued – 5-year-old male phantom)

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
78	Transverse colon wall, right	151	191	53	86	303	346	172.17	66.41	324.90	14.63	5.65	62.64
79	Transverse colon content, right	152	190	58	81	305	344	172.15	66.59	324.86	14.63	5.66	62.63
80	Transverse colon wall, left	188	270	48	91	301	349	231.34	65.28	323.80	19.66	5.55	62.43
81	Transverse colon content, left	189	267	52	87	302	347	231.38	65.42	323.87	19.67	5.56	62.44
82	Descending colon wall, left	255	305	71	127	310	347	285.72	101.01	329.72	24.29	8.59	63.57
83	Descending colon content, left	259	300	75	123	311	346	285.25	100.89	329.62	24.25	8.58	63.55
84	Sigmoid colon wall	162	294	104	175	267	314	225.70	147.94	291.52	19.18	12.57	56.20
85	Sigmoid colon content	164	291	107	173	256	314	228.12	144.87	293.00	19.39	12.31	56.49
86	Rectum wall	205	219	153	168	256	268	210.65	159.59	261.66	17.91	13.57	50.45
Heart													
87	Heart wall	164	282	62	130	394	433	219.99	96.33	409.23	18.70	8.19	78.90
88	Heart chamber contents (blood)	168	274	67	126	396	431	215.79	98.27	410.72	18.34	8.35	79.19
Kidneys													
89	Kidney, left, cortex	227	278	135	177	336	377	253.28	157.03	356.20	21.53	13.35	68.68
90	Kidney, left, medulla	234	268	142	170	343	370	250.85	156.26	356.22	21.32	13.28	68.68
91	Kidney, left, pelvis	239	257	147	162	349	364	247.78	154.90	355.93	21.06	13.17	68.62
92	Kidney, right cortex	139	189	135	177	332	373	162.56	157.03	352.20	13.82	13.35	67.90
93	Kidney, right medulla	149	183	142	170	339	366	165.02	156.25	352.16	14.03	13.28	67.90
94	Kidney, right pelvis	159	178	147	162	346	360	168.01	154.95	352.06	14.28	13.17	67.88
95	Liver	101	261	60	181	338	399	163.11	111.02	376.73	13.86	9.44	72.63
Lungs													
96	Lung, left, blood	234	300	91	169	407	456	262.11	146.75	425.96	22.28	12.47	82.12
97	Lung, left, air-filled tissue	218	318	73	188	392	460	265.36	143.08	424.43	22.56	12.16	81.83
98	Lung, right blood	114	182	92	177	407	453	156.26	140.52	423.85	13.28	11.94	81.72
99	Lung, right air-filled tissue	101	197	72	192	395	459	150.21	135.14	424.62	12.77	11.49	81.87
Lymphatic nodes													
100	Lymphatic nodes, ET airways	174	244	63	148	433	510	208.50	106.37	479.76	17.72	9.04	92.50
101	Lymphatic nodes, thoracic airways	171	247	112	168	348	466	208.50	136.64	399.26	17.72	11.61	76.98
102	Lymphatic nodes, head	172	246	103	144	457	495	208.50	119.49	468.37	17.72	10.16	90.30
103	Lymphatic nodes, trunk	61	357	34	176	212	445	208.50	116.05	319.55	17.72	9.86	61.61
104	Lymphatic nodes, arms	18	400	112	152	307	386	208.50	130.15	342.92	17.72	11.06	66.11
105	Lymphatic nodes, legs	120	298	119	164	95	198	208.50	132.50	143.63	17.72	11.26	27.69
Muscle (skeletal)													
106	Muscle, head	129	292	23	221	468	567	209.49	108.98	501.49	17.81	9.26	96.69
107	Muscle, trunk	56	364	31	207	245	472	210.74	119.51	376.37	17.91	10.16	72.56
108	Muscle, arms	6	414	70	165	212	453	209.53	130.75	350.02	17.81	11.11	67.48
109	Muscle, legs	99	321	31	196	2	279	209.50	144.02	167.10	17.81	12.24	32.22
110	Oesophagus wall	203	233	117	141	385	475	211.11	132.23	429.23	17.94	11.24	82.76
Ovaries													
111	Ovary, left												
112	Ovary, right												
113	Pancreas	213	310	109	147	345	364	259.56	127.91	355.47	22.06	10.87	68.53
114	Pituitary gland	206	214	91	99	524	527	209.50	94.97	525.19	17.81	8.07	101.26
115	Prostate	201	219	123	135	261	267	209.17	128.09	263.87	17.78	10.89	50.88
Residual tissue													
116	Residual tissue, head	125	295	19	229	468	571	207.83	124.68	528.60	17.67	10.60	101.91
117	Residual tissue, trunk	52	366	28	222	246	481	212.74	134.12	359.82	18.08	11.40	69.37
118	Residual tissue, arms	2	418	71	181	212	453	209.44	135.61	369.46	17.80	11.53	71.23

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887 Table A.6. (continued – 5-year-old male phantom)

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
119	Residual tissue, legs	85	335	45	211	3	279	209.47	147.85	187.05	17.80	12.57	36.06
	Salivary glands												
120	Salivary glands, left	212	272	50	130	477	501	246.57	101.98	487.28	20.96	8.67	93.95
121	Salivary glands, right	148	208	50	130	477	501	172.43	101.98	487.28	14.66	8.67	93.95
	Skin												
122	Skin, head	111	309	1	230	468	572	209.62	121.17	520.75	17.82	10.30	100.40
123	Skin, trunk	50	368	27	223	244	479	209.68	129.65	365.42	17.82	11.02	70.45
124	Skin, arms	1	419	69	181	212	453	209.99	126.94	329.13	17.85	10.79	63.46
125	Skin, legs	84	336	30	212	1	275	209.54	144.18	146.27	17.81	12.26	28.20
126	Spinal cord	202	216	137	197	291	490	208.33	162.53	394.00	17.71	13.81	75.96
127	Spleen	247	321	123	182	359	391	288.30	154.73	376.46	24.51	13.15	72.58
128	Teeth	176	247	26	71	484	497	210.96	50.53	490.25	17.93	4.29	94.52
	Testes												
129	Testis, left	211	221	116	128	251	258	215.73	121.94	254.25	18.34	10.36	49.02
130	Testis, right	199	209	116	128	251	258	203.28	121.94	254.25	17.28	10.36	49.02
131	Thymus	176	235	74	120	424	455	205.51	98.63	437.95	17.47	8.38	84.44
132	Thyroid	193	230	94	114	457	468	210.59	102.43	462.32	17.90	8.71	89.13
133	Tongue (inner part)	193	228	50	106	481	494	209.72	79.38	487.29	17.83	6.75	93.95
134	Tonsils	189	231	110	122	485	491	209.50	115.22	487.17	17.81	9.79	93.93
	Uretrs												
135	Ureter, left	221	237	122	153	293	355	230.84	138.43	323.13	19.62	11.77	62.30
136	Ureter, right	183	199	122	153	293	355	188.16	138.44	323.16	15.99	11.77	62.30
137	Urinary bladder wall	176	243	99	159	268	292	209.15	129.38	279.78	17.78	11.00	53.94
138	Urinary bladder contents	179	241	101	157	269	291	209.29	129.67	279.65	17.79	11.02	53.92
139	Uterus and cervix												
140	Air inside the body	172	297	7	145	387	529	231.51	91.65	457.45	19.68	7.79	88.20

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890 Table A.7. ID listings, rectangular prism (box) containing the organ (minimum/maximum
 891 columns, rows, and slices occupied by each organ/tissue), and organs centres of mass (in terms of
 892 voxels as well as co-ordinates) for the *5-year-old female phantom*.

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
Adrenals													
1	Adrenal gland, left	227	253	160	179	374	387	236.33	169.73	379.83	20.09	14.43	73.23
2	Adrenal gland, right	161	190	160	180	371	384	177.81	169.54	375.74	15.11	14.41	72.44
Airways (and mouth)													
3	Anterior nasal passage (ET ₁)	204	222	6	18	504	514	212.47	12.05	505.80	18.06	1.02	97.52
4	Posterior nasal passage (ET ₂)	171	252	17	119	479	529	209.85	68.36	506.73	17.84	5.81	97.70
5	Oral mucosa, tongue	194	226	51	103	485	494	209.47	75.43	492.35	17.80	6.41	94.93
6	Oral mucosa, lips & cheeks	180	241	21	38	486	495	209.39	27.40	489.92	17.80	2.33	94.46
7	Trachea	205	215	109	130	442	461	209.38	119.35	450.81	17.80	10.14	86.92
8	Bronchi	184	236	120	131	430	441	209.49	125.56	433.66	17.81	10.67	83.61
Blood vessels													
9	Blood vessels, head	105	315	133	169	450	494	209.48	148.29	467.16	17.81	12.60	90.07
10	Blood vessels, trunk	189	229	117	152	375	466	209.06	131.29	424.43	17.77	11.16	81.83
11	Blood vessels, arms	11	409	112	173	275	447	209.50	131.33	360.65	17.81	11.16	69.53
12	Blood vessels, legs	119	301	124	178	31	271	209.50	143.04	150.71	17.81	12.16	29.06
Bones:													
Arm bones:													
13	Humeri, proximal end, cortical bone	51	369	135	164	402	452	209.50	147.04	431.79	17.81	12.50	83.25
14	Humeri, upper half, spongiosa	61	359	137	161	434	452	209.50	148.45	443.20	17.81	12.62	85.45
15	Humeri, upper half, medullary cavity	54	366	141	150	402	434	209.50	144.23	418.99	17.81	12.26	80.78
16	Humeri, lower half, cortical bone	22	398	121	149	345	402	209.50	138.41	370.72	17.81	11.76	71.47
17	Humeri, lower half, spongiosa	25	395	124	143	346	368	209.50	134.23	355.30	17.81	11.41	68.50
18	Humeri, lower half, medullary cavity	42	378	138	146	368	402	209.50	142.18	384.32	17.81	12.08	74.10
19	Ulnae and radii, cortical bone	11	409	100	165	89	355	208.25	125.94	314.35	17.70	10.71	60.61
20	Ulnae and radii, spongiosa	13	407	102	145	269	355	209.50	127.93	322.22	17.81	10.87	62.12
21	Ulnae and radii, medullary cavity	16	404	108	141	282	338	209.38	125.37	312.10	17.80	10.66	60.17
22	Wrists and hand bones, cortical bone	7	413	72	138	213	269	209.50	107.23	245.50	17.81	9.11	47.33
23	Wrists and hand bones, spongiosa	8	412	72	137	214	269	209.50	106.82	249.50	17.81	9.08	48.10
Clavicles													
24	Clavicles, cortical bone	88	332	93	149	449	455	209.50	118.18	451.73	17.81	10.05	87.09
25	Clavicles, spongiosa	89	331	94	148	449	455	209.50	116.71	451.57	17.81	9.92	87.06
Cranium													
26	Cranium, cortical bone	128	291	17	224	491	569	210.04	120.96	527.18	17.85	10.28	101.64
27	Cranium, spongiosa	129	290	17	223	491	568	210.33	126.11	532.27	17.88	10.72	102.62
Leg bones:													
28	Femora proximal end, cortical bone	106	314	127	158	195	282	209.50	144.09	244.42	17.81	12.25	47.13
29	Femora upper half, spongiosa	109	311	130	154	255	281	209.50	140.81	267.73	17.81	11.97	51.62
30	Femora upper half, medullary cavity	119	301	143	151	195	254	209.50	146.18	224.82	17.81	12.43	43.34
31	Femora lower half, cortical bone	127	293	134	173	144	194	209.50	150.88	162.43	17.81	12.82	31.32
32	Femora lower half, spongiosa	130	290	138	167	145	163	209.50	151.32	152.88	17.81	12.86	29.48
33	Femora lower half, medullary cavity	136	284	143	151	164	194	209.50	147.00	176.71	17.81	12.50	34.07
34	Tibiae, fibulae, and patellae, cortical bone	127	293	123	171	26	158	209.47	151.24	95.01	17.81	12.86	18.32
35	Tibiae, fibulae, and patellae, spongiosa	131	289	124	169	26	157	209.50	146.55	119.01	17.81	12.46	22.94
36	Tibiae, fibulae, and patellae, medullary cavity	135	285	144	167	46	123	209.61	150.67	86.60	17.82	12.81	16.70
37	Ankles and foot bones, cortical bone	122	298	33	183	4	30	209.50	120.48	14.86	17.81	10.24	2.87
38	Ankles and foot bones, spongiosa	123	297	34	182	4	29	209.50	135.49	16.47	17.81	11.52	3.18
39	Mandible, cortical bone	153	270	26	111	479	508	211.98	70.45	488.96	18.02	5.99	94.27
40	Mandible, spongiosa	154	269	26	110	479	507	211.28	66.41	486.93	17.96	5.64	93.88

895 Table A.7. (continued – 5-year-old female phantom)

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
Pelvis													
41	Pelvis, cortical bone	96	324	110	188	255	319	209.50	145.81	290.18	17.81	12.39	55.95
42	Pelvis, spongiosa	97	323	112	187	256	318	209.50	147.00	288.88	17.81	12.50	55.70
Ribs													
43	Ribs, cortical bone	90	330	59	197	345	465	209.59	145.18	408.81	17.82	12.34	78.82
44	Ribs, spongiosa	91	329	60	197	345	465	209.51	143.87	410.09	17.81	12.23	79.06
Scapulae													
45	Scapulae, cortical bone	75	345	147	204	409	452	209.50	183.15	435.11	17.81	15.57	83.89
46	Scapulae, spongiosa	76	344	148	203	410	452	209.50	178.23	437.42	17.81	15.15	84.33
Spine													
47	Cervical spine, cortical bone	183	239	126	174	464	493	208.86	142.42	478.25	17.75	12.11	92.21
48	Cervical spine, spongiosa	183	238	127	173	464	493	208.91	141.09	478.46	17.76	11.99	92.25
49	Thoracic spine, cortical bone	182	233	131	192	366	465	207.65	163.75	416.61	17.65	13.92	80.32
50	Thoracic spine, spongiosa	184	232	132	192	366	465	207.59	161.70	416.68	17.65	13.74	80.34
51	Lumbar spine, cortical bone	184	239	122	189	314	367	209.18	152.08	340.76	17.78	12.93	65.70
52	Lumbar spine, spongiosa	187	241	122	188	314	367	209.49	146.17	339.45	17.81	12.42	65.45
Sacrum													
53	Sacrum, cortical bone	172	250	139	201	281	317	209.19	170.35	302.60	17.78	14.48	58.34
54	Sacrum, spongiosa	172	249	140	201	282	317	209.58	162.59	304.90	17.81	13.82	58.79
Sternum													
55	Sternum, cortical bone	191	227	56	91	410	450	209.25	72.73	432.04	17.79	6.18	83.30
56	Sternum, spongiosa	192	228	57	91	410	449	208.96	73.44	433.03	17.76	6.24	83.49
Cartilage													
57	Cartilage, head	112	308	2	150	461	520	210.09	94.66	492.56	17.86	8.05	94.97
58	Cartilage, trunk	112	308	53	164	311	484	209.10	111.64	386.93	17.77	9.49	74.60
59	Cartilage, arms												
60	Cartilage, legs												
61	Brain	135	284	36	216	491	564	209.81	134.15	531.42	17.83	11.40	102.46
Breasts													
62	Breast, left, adipose tissue	265	296	39	51	396	408	280.24	44.65	401.84	23.82	3.80	77.47
63	Breast, left, glandular tissue	271	291	41	50	398	406	280.13	44.94	401.70	23.81	3.82	77.45
64	Breast, right, adipose tissue	124	155	39	51	396	408	138.76	44.65	401.84	11.79	3.80	77.47
65	Breast, right, glandular tissue	129	149	41	50	398	406	138.88	44.94	401.70	11.80	3.82	77.45
Eyes													
66	Eye lens, left	237	246	34	37	517	521	240.90	34.83	518.47	20.48	2.96	99.96
67	Eye bulb, left	228	254	32	56	514	524	240.63	44.04	518.77	20.45	3.74	100.02
68	Eye lens, right	174	183	34	37	517	521	178.10	34.83	518.47	15.14	2.96	99.96
69	Eye bulb, right	166	192	32	56	514	524	178.37	44.04	518.77	15.16	3.74	100.02
Gallbladder													
70	Gallbladder wall	150	185	85	145	349	369	167.42	114.49	357.78	14.23	9.73	68.98
71	Gallbladder contents	150	185	86	144	349	368	167.19	109.80	357.35	14.21	9.33	68.90
Gastrointestinal tract													
72	Stomach wall	224	305	62	148	351	394	268.55	104.86	372.49	22.83	8.91	71.82
73	Stomach contents	225	299	66	145	353	386	268.96	105.82	371.76	22.86	9.00	71.68
74	Small intestine wall	124	299	71	161	257	358	205.27	101.30	319.89	17.45	8.61	61.67
75	Small intestine contents	129	294	76	132	292	354	204.85	101.17	319.70	17.41	8.60	61.64
76	Ascending colon wall	114	157	64	145	285	346	132.73	116.08	319.40	11.28	9.87	61.58
77	Ascending colon contents	119	155	69	140	286	344	132.99	115.79	319.68	11.30	9.84	61.63

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898 Table A.7. (continued – 5-year-old female phantom)

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
78	Transverse colon wall, right	151	191	53	86	303	346	172.17	66.41	324.90	14.63	5.65	62.64
79	Transverse colon content, right	152	190	58	81	305	344	172.15	66.59	324.86	14.63	5.66	62.63
80	Transverse colon wall, left	188	270	48	91	301	349	231.34	65.28	323.80	19.66	5.55	62.43
81	Transverse colon content, left	189	267	52	87	302	347	231.38	65.42	323.87	19.67	5.56	62.44
82	Descending colon wall, left	255	305	71	127	310	347	285.72	101.01	329.72	24.29	8.59	63.57
83	Descending colon content, left	259	300	75	123	311	346	285.25	100.89	329.63	24.25	8.58	63.55
84	Sigmoid colon wall	162	294	104	175	267	314	225.68	147.95	291.51	19.18	12.58	56.20
85	Sigmoid colon content	164	292	108	173	256	314	228.13	144.87	293.01	19.39	12.31	56.49
86	Rectum wall	205	219	153	168	256	268	210.65	159.61	261.66	17.91	13.57	50.45
Heart													
87	Heart wall	164	282	62	130	394	433	219.99	96.33	409.23	18.70	8.19	78.90
88	Heart chamber contents (blood)	168	274	67	126	396	431	215.79	98.27	410.72	18.34	8.35	79.19
Kidneys													
89	Kidney, left, cortex	227	278	135	177	336	377	253.28	157.03	356.20	21.53	13.35	68.68
90	Kidney, left, medulla	234	268	142	170	343	370	250.85	156.26	356.22	21.32	13.28	68.68
91	Kidney, left, pelvis	239	257	147	162	349	364	247.78	154.90	355.93	21.06	13.17	68.62
92	Kidney, right cortex	139	189	135	177	332	373	162.56	157.03	352.20	13.82	13.35	67.90
93	Kidney, right medulla	149	183	142	170	339	366	165.02	156.25	352.16	14.03	13.28	67.90
94	Kidney, right pelvis	159	178	147	162	346	360	168.01	154.95	352.06	14.28	13.17	67.88
95	Liver	101	261	60	181	338	399	163.11	111.02	376.73	13.86	9.44	72.63
Lungs													
96	Lung, left, blood	234	300	91	169	407	456	262.11	146.75	425.96	22.28	12.47	82.12
97	Lung, left, air-filled tissue	218	318	73	188	392	460	265.36	143.08	424.43	22.56	12.16	81.83
98	Lung, right blood	114	182	92	177	407	453	156.26	140.52	423.85	13.28	11.94	81.72
99	Lung, right air-filled tissue	101	197	72	192	395	459	150.21	135.14	424.62	12.77	11.49	81.87
Lymphatic nodes													
100	Lymphatic nodes, ET airways	172	246	70	144	433	506	208.50	104.17	480.24	17.72	8.85	92.59
101	Lymphatic nodes, thoracic airways	172	246	116	172	347	463	208.50	136.62	402.97	17.72	11.61	77.69
102	Lymphatic nodes, head	170	248	99	155	458	495	208.50	122.72	470.77	17.72	10.43	90.76
103	Lymphatic nodes, trunk	60	358	35	176	223	445	208.50	116.57	320.59	17.72	9.91	61.81
104	Lymphatic nodes, arms	23	395	112	156	302	387	208.50	125.71	343.32	17.72	10.69	66.19
105	Lymphatic nodes, legs	118	300	122	172	84	190	208.50	135.31	142.13	17.72	11.50	27.40
Muscle (skeletal)													
106	Muscle, head	129	292	23	221	468	567	209.50	109.09	501.78	17.81	9.27	96.74
107	Muscle, trunk	56	364	31	207	256	472	210.74	119.88	377.80	17.91	10.19	72.84
108	Muscle, arms	6	414	70	165	212	453	209.54	130.75	349.92	17.81	11.11	67.47
109	Muscle, legs	99	321	31	196	2	279	209.50	144.00	167.06	17.81	12.24	32.21
110	Oesophagus wall	203	233	117	141	385	477	211.07	132.09	429.80	17.94	11.23	82.87
Ovaries													
111	Ovary, left	228	242	121	133	288	294	234.88	126.55	290.82	19.96	10.76	56.07
112	Ovary, right	178	192	121	133	288	294	184.12	126.55	290.82	15.65	10.76	56.07
113	Pancreas	213	310	109	147	345	364	259.56	127.91	355.47	22.06	10.87	68.53
114	Pituitary gland	206	214	91	99	524	527	209.50	94.97	525.19	17.81	8.07	101.26
Prostate													
Residual tissue													
116	Residual tissue, head	125	295	19	229	468	571	207.77	124.85	528.54	17.66	10.61	101.90
117	Residual tissue, trunk	52	366	28	222	253	481	212.75	134.35	359.75	18.08	11.42	69.36
118	Residual tissue, arms	2	418	71	181	212	453	209.44	135.63	369.56	17.80	11.53	71.25

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901 Table A.7. (continued – 5-year-old female phantom)

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
119	Residual tissue, legs	85	335	45	211	3	279	209.47	147.87	186.90	17.80	12.57	36.03
	Salivary glands												
120	Salivary glands, left	212	272	50	130	477	501	246.57	101.98	487.28	20.96	8.67	93.95
121	Salivary glands, right	148	208	50	130	477	501	172.43	101.98	487.28	14.66	8.67	93.95
	Skin												
122	Skin, head	111	309	1	230	468	572	209.62	121.16	520.75	17.82	10.30	100.40
123	Skin, trunk	50	368	27	223	253	479	209.69	129.90	366.56	17.82	11.04	70.67
124	Skin, arms	1	419	69	181	212	453	209.99	126.94	329.13	17.85	10.79	63.46
125	Skin, legs	84	336	30	212	1	275	209.54	144.15	146.35	17.81	12.25	28.22
126	Spinal cord	202	216	137	197	291	490	208.33	162.53	394.00	17.71	13.81	75.96
127	Spleen	247	321	123	182	359	391	288.30	154.73	376.46	24.51	13.15	72.58
128	Teeth	176	247	26	71	484	497	210.96	50.53	490.25	17.93	4.29	94.52
	Testes												
129	Testis, left												
130	Testis, right												
131	Thymus	176	235	74	120	424	455	205.51	98.63	437.95	17.47	8.38	84.44
132	Thyroid	193	230	94	114	457	468	210.59	102.43	462.32	17.90	8.71	89.13
133	Tongue (inner part)	193	228	50	106	481	494	209.72	79.38	487.29	17.83	6.75	93.95
134	Tonsils	189	231	110	122	485	491	209.50	115.22	487.17	17.81	9.79	93.93
	Ureters												
135	Ureter, left	221	237	122	153	293	355	230.84	138.43	323.13	19.62	11.77	62.30
136	Ureter, right	183	199	122	153	293	355	188.16	138.44	323.16	15.99	11.77	62.30
137	Urinary bladder wall	176	243	78	141	270	293	209.26	109.79	280.81	17.79	9.33	54.14
138	Urinary bladder contents	179	241	81	139	271	292	209.27	110.19	280.78	17.79	9.37	54.13
139	Uterus and cervix	195	223	125	145	284	294	208.97	135.50	289.52	17.76	11.52	55.82
140	Air inside the body	172	297	7	145	387	529	231.51	91.62	457.51	19.68	7.79	88.21

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904 Table A.8. ID listings, rectangular prism (box) containing the organ (minimum/maximum
 905 columns, rows, and slices occupied by each organ/tissue), and organs centres of mass (in terms of
 906 voxels as well as co-ordinates) for the *10-year-old male phantom*.

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
Adrenals													
1	Adrenal gland, left	228	250	158	181	395	405	237.63	167.66	399.39	23.53	16.60	96.85
2	Adrenal gland, right	166	188	157	185	390	399	176.30	170.20	394.04	17.45	16.85	95.56
Airways (and mouth)													
3	Anterior nasal passage (ET ₁)	203	219	11	21	521	529	210.91	16.07	522.21	20.88	1.59	126.64
4	Posterior nasal passage (ET ₂)	175	245	21	115	499	541	208.97	66.49	522.76	20.69	6.58	126.77
5	Oral mucosa, tongue	193	225	46	96	499	513	209.81	70.95	511.54	20.77	7.02	124.05
6	Oral mucosa, lips & cheeks	185	236	22	38	508	514	209.66	27.88	510.59	20.76	2.76	123.82
7	Trachea	204	216	108	131	460	485	209.26	118.62	471.55	20.72	11.74	114.35
8	Bronchi	191	229	122	135	448	459	212.57	128.34	452.28	21.04	12.71	109.68
Blood vessels													
9	Blood vessels, head	97	323	125	154	476	513	209.50	134.85	489.33	20.74	13.35	118.66
10	Blood vessels, trunk	194	224	124	147	390	483	209.25	138.91	439.44	20.72	13.75	106.56
11	Blood vessels, arms	7	413	82	153	291	468	209.50	105.28	378.63	20.74	10.42	91.82
12	Blood vessels, legs	111	309	113	174	39	282	209.50	136.96	164.33	20.74	13.56	39.85
Bones:													
Arm bones:													
13	Humeri, proximal end, cortical bone	49	371	108	146	423	476	209.50	124.07	455.05	20.74	12.28	110.35
14	Humeri, upper half, spongiosa	62	358	110	188	457	550	209.53	125.84	466.05	20.74	12.46	113.02
15	Humeri, upper half, medullary cavity	53	367	103	145	423	486	209.50	120.89	440.93	20.74	11.97	106.93
16	Humeri, lower half, cortical bone	12	408	93	128	364	423	209.50	114.43	389.46	20.74	11.33	94.44
17	Humeri, lower half, spongiosa	17	403	99	120	364	387	209.50	110.11	374.50	20.74	10.90	90.82
18	Humeri, lower half, medullary cavity	38	382	113	125	387	423	209.50	119.17	404.76	20.74	11.80	98.15
19	Ulnae and radii, cortical bone	10	410	65	127	283	374	209.50	99.07	331.86	20.74	9.81	80.48
20	Ulnae and radii, spongiosa	14	406	69	123	285	374	209.50	102.21	340.14	20.74	10.12	82.48
21	Ulnae and radii, medullary cavity	15	405	73	120	297	356	208.84	98.00	328.63	20.68	9.70	79.69
22	Wrists and hand bones, cortical bone	9	411	28	113	227	284	209.50	74.13	260.34	20.74	7.34	63.13
23	Wrists and hand bones, spongiosa	10	410	30	113	226	284	209.50	73.59	264.19	20.74	7.29	64.07
Clavicles													
24	Clavicles, cortical bone	85	335	83	124	463	479	209.50	103.28	473.02	20.74	10.22	114.71
25	Clavicles, spongiosa	86	334	84	123	463	478	209.50	100.10	472.51	20.74	9.91	114.58
Cranium													
26	Cranium, cortical bone	137	280	20	201	510	573	208.71	110.36	539.47	20.66	10.93	130.82
27	Cranium, spongiosa	138	279	20	200	511	573	209.37	116.19	544.03	20.73	11.50	131.93
Leg bones:													
28	Femora proximal end, cortical bone	93	327	119	162	203	293	209.50	141.85	255.89	20.74	14.04	62.05
29	Femora upper half, spongiosa	97	323	123	157	265	292	209.50	138.35	278.30	20.74	13.70	67.49
30	Femora upper half, medullary cavity	111	309	140	150	203	264	209.50	144.14	233.87	20.74	14.27	56.71
31	Femora lower half, cortical bone	119	301	126	178	150	202	209.50	148.03	169.52	20.74	14.66	41.11
32	Femora lower half, spongiosa	122	298	131	169	151	170	209.50	148.44	159.00	20.74	14.70	38.56
33	Femora lower half, medullary cavity	130	290	140	150	170	202	209.50	144.70	183.70	20.74	14.33	44.55
34	Tibiae, fibulae, and patellae, cortical bone	120	300	114	175	27	164	209.50	148.33	99.10	20.74	14.69	24.03
35	Tibiae, fibulae, and patellae, spongiosa	125	295	114	173	28	164	209.50	142.76	124.70	20.74	14.13	30.24
36	Tibiae, fibulae, and patellae, medullary cavity	131	289	137	168	47	128	209.50	147.39	90.19	20.74	14.59	21.87
37	Ankles and foot bones, cortical bone	126	294	4	186	4	32	209.49	111.86	16.34	20.74	11.07	3.96
38	Ankles and foot bones, spongiosa	126	294	7	185	5	32	209.50	130.14	18.06	20.74	12.88	4.38
39	Mandible, cortical bone	158	262	25	103	501	524	209.92	66.86	508.91	20.78	6.62	123.41
40	Mandible, spongiosa	160	260	26	102	501	523	208.60	63.98	507.23	20.65	6.33	123.00

907
908

909 Table A.8. (continued – 10-year-old male phantom)

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
Pelvis													
41	Pelvis, cortical bone	98	324	86	185	267	340	210.54	137.67	305.49	20.84	13.63	74.08
42	Pelvis, spongiosa	99	323	87	184	268	339	210.70	138.98	303.74	20.86	13.76	73.66
Ribs													
43	Ribs, cortical bone	89	331	49	201	361	479	209.50	142.19	424.48	20.74	14.08	102.94
44	Ribs, spongiosa	90	330	50	201	361	479	209.50	141.12	426.25	20.74	13.97	103.37
Scapulae													
45	Scapulae, cortical bone	66	354	135	202	429	480	209.50	178.13	459.70	20.74	17.64	111.48
46	Scapulae, spongiosa	67	353	136	201	430	479	209.50	171.92	462.50	20.74	17.02	112.16
Spine													
47	Cervical spine, cortical bone	178	242	114	174	480	512	208.41	135.77	496.02	20.63	13.44	120.29
48	Cervical spine, spongiosa	179	241	114	173	480	512	208.55	133.76	496.41	20.65	13.24	120.38
49	Thoracic spine, cortical bone	176	240	133	206	374	480	207.01	170.55	429.04	20.49	16.88	104.04
50	Thoracic spine, spongiosa	177	239	133	206	375	480	207.46	168.37	427.59	20.54	16.67	103.69
51	Lumbar spine, cortical bone	178	245	127	202	321	378	209.64	159.93	348.88	20.75	15.83	84.60
52	Lumbar spine, spongiosa	179	243	128	202	321	378	209.96	155.06	348.49	20.79	15.35	84.51
Sacrum													
53	Sacrum, cortical bone	177	245	149	211	288	327	209.97	181.60	309.86	20.79	17.98	75.14
54	Sacrum, spongiosa	178	244	149	211	288	326	209.60	173.59	312.68	20.75	17.19	75.83
Sternum													
55	Sternum, cortical bone	190	232	43	93	425	467	209.92	65.16	449.59	20.78	6.45	109.03
56	Sternum, spongiosa	191	231	43	92	425	467	210.22	67.42	451.59	20.81	6.67	109.51
Cartilage													
57	Cartilage, head	127	293	7	117	484	536	209.69	76.09	507.04	20.76	7.53	122.96
58	Cartilage, trunk	109	311	37	188	318	550	209.13	114.44	397.03	20.70	11.33	96.28
59	Cartilage, arms												
60	Cartilage, legs												
61	Brain	143	273	37	194	511	570	208.92	122.59	543.11	20.68	12.14	131.71
Breasts													
62	Breast, left, adipose tissue	260	285	16	28	421	431	272.03	21.50	425.41	26.93	2.13	103.16
63	Breast, left, glandular tissue	265	281	18	27	423	429	272.31	21.57	425.50	26.96	2.14	103.18
64	Breast, right, adipose tissue	135	160	16	28	421	431	146.98	21.50	425.41	14.55	2.13	103.16
65	Breast, right, glandular tissue	139	155	18	27	423	429	146.69	21.57	425.50	14.52	2.14	103.18
Eyes													
66	Eye lens, left	233	241	35	38	532	535	236.29	36.28	532.71	23.39	3.59	129.18
67	Eye bulb, left	225	248	33	55	529	537	235.91	43.99	532.77	23.35	4.36	129.20
68	Eye lens, right	179	187	35	38	532	535	182.71	36.28	532.71	18.09	3.59	129.18
69	Eye bulb, right	172	195	33	55	529	537	183.09	43.99	532.77	18.13	4.36	129.20
Gallbladder													
70	Gallbladder wall	130	172	87	128	379	396	149.83	105.29	387.06	14.83	10.42	93.86
71	Gallbladder contents	131	172	89	127	379	395	149.99	106.72	387.49	14.85	10.57	93.97
Gastrointestinal tract													
72	Stomach wall	198	292	55	150	377	410	254.84	97.67	393.15	25.23	9.67	95.34
73	Stomach contents	199	286	62	145	378	400	251.82	95.98	390.93	24.93	9.50	94.80
74	Small intestine wall	115	310	56	132	16	392	207.21	94.89	346.72	20.51	9.39	84.08
75	Small intestine contents	118	306	59	129	315	388	207.11	95.40	347.35	20.50	9.44	84.23
76	Ascending colon wall	111	148	54	132	308	373	127.81	103.13	343.67	12.65	10.21	83.34
77	Ascending colon contents	117	144	59	127	308	371	128.07	102.99	343.15	12.68	10.20	83.21

910
911

912 Table A.8. (continued – 10-year-old male phantom)

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
78	Transverse colon wall, right	140	205	42	74	340	373	172.92	54.55	356.72	17.12	5.40	86.50
79	Transverse colon content, right	142	205	47	69	342	371	172.86	54.63	356.78	17.11	5.41	86.52
80	Transverse colon wall, left	206	297	40	86	340	380	242.53	56.34	361.32	24.01	5.58	87.62
81	Transverse colon content, left	206	295	45	81	342	378	242.39	56.36	361.20	24.00	5.58	87.59
82	Descending colon wall, left	277	315	66	116	338	375	297.94	93.37	355.62	29.50	9.24	86.24
83	Descending colon content, left	281	310	71	111	338	373	297.47	93.36	355.53	29.45	9.24	86.22
84	Sigmoid colon wall	171	294	96	170	285	340	228.40	135.17	313.96	22.61	13.38	76.13
85	Sigmoid colon content	174	293	98	167	272	340	232.93	130.83	316.45	23.06	12.95	76.74
86	Rectum wall	200	213	156	170	272	284	205.29	162.43	277.57	20.32	16.08	67.31
Heart													
87	Heart wall	156	267	49	138	416	454	215.10	92.40	431.72	21.29	9.15	104.69
88	Heart chamber contents (blood)	180	264	54	132	419	453	218.70	91.45	432.74	21.65	9.05	104.94
Kidneys													
89	Kidney, left, cortex	232	285	146	185	361	399	259.39	165.54	379.59	25.68	16.39	92.05
90	Kidney, left, medulla	239	274	153	179	368	393	256.88	165.82	379.55	25.43	16.42	92.04
91	Kidney, left, pelvis	244	263	159	173	374	386	253.41	165.94	379.46	25.09	16.43	92.02
92	Kidney, right cortex	132	185	146	185	355	393	156.74	165.53	373.55	15.52	16.39	90.59
93	Kidney, right medulla	143	178	153	179	362	387	159.21	165.81	373.52	15.76	16.42	90.58
94	Kidney, right pelvis	154	173	159	173	367	380	162.68	165.95	373.44	16.11	16.43	90.56
95	Liver	103	274	45	191	363	420	163.58	108.45	400.19	16.19	10.74	97.05
Lungs													
96	Lung, left, blood	249	301	80	160	423	473	270.70	137.51	441.68	26.80	13.61	107.11
97	Lung, left, air-filled tissue	216	306	65	184	413	477	261.65	134.51	444.91	25.90	13.32	107.89
98	Lung, right blood	119	185	81	169	425	471	162.37	129.69	441.29	16.07	12.84	107.01
99	Lung, right air-filled tissue	104	205	64	188	416	475	155.73	126.53	441.98	15.42	12.53	107.18
Lymphatic nodes													
100	Lymphatic nodes, ET airways	169	249	80	163	453	522	208.50	116.82	499.57	20.64	11.57	121.15
101	Lymphatic nodes, thoracic airways	168	250	116	201	366	499	208.52	156.83	423.86	20.64	15.53	102.79
102	Lymphatic nodes, head	169	249	105	169	481	500	208.50	139.94	487.63	20.64	13.85	118.25
103	Lymphatic nodes, trunk	51	367	26	197	275	479	208.50	136.14	347.90	20.64	13.48	84.36
104	Lymphatic nodes, arms	20	398	88	144	327	426	208.50	117.79	385.05	20.64	11.66	93.37
105	Lymphatic nodes, legs	111	307	125	185	227	316	208.50	156.92	263.34	20.64	15.54	63.86
Muscle (skeletal)													
106	Muscle, head	140	281	22	203	497	575	210.91	96.21	526.30	20.88	9.52	127.63
107	Muscle, trunk	54	366	19	217	262	511	209.69	121.41	392.77	20.76	12.02	95.25
108	Muscle, arms	3	417	25	155	225	477	209.51	106.69	361.24	20.74	10.56	87.60
109	Muscle, legs	90	330	2	192	2	290	209.48	138.15	177.35	20.74	13.68	43.01
110	Oesophagus wall	203	229	112	145	402	496	211.34	134.43	448.80	20.92	13.31	108.83
Ovaries													
111	Ovary, left												
112	Ovary, right												
113	Pancreas	182	298	101	145	375	389	236.07	123.35	381.65	23.37	12.21	92.55
114	Pituitary gland	206	214	83	90	537	540	209.50	86.21	538.07	20.74	8.53	130.48
115	Prostate	201	218	119	131	277	282	209.55	124.55	279.39	20.75	12.33	67.75
Residual tissue													
116	Residual tissue, head	137	283	18	207	496	575	210.16	111.55	538.38	20.81	11.04	130.56
117	Residual tissue, trunk	52	367	18	225	266	511	212.04	128.32	383.08	20.99	12.70	92.90
118	Residual tissue, arms	2	418	71	168	301	477	208.55	123.89	420.81	20.65	12.27	102.05

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915 Table A.8. (continued – *10-year-old male phantom*)

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
119	Residual tissue, legs	78	342	47	204	2	290	209.54	140.28	216.58	20.74	13.89	52.52
	Salivary glands												
120	Salivary glands, left	212	265	46	120	498	518	241.72	95.57	506.40	23.93	9.46	122.80
121	Salivary glands, right	155	208	46	120	498	518	177.28	95.57	506.40	17.55	9.46	122.80
	Skin												
122	Skin, head	126	294	6	208	496	576	209.54	108.87	536.97	20.74	10.78	130.22
123	Skin, trunk	50	368	15	226	10	510	209.57	125.06	384.79	20.75	12.38	93.31
124	Skin, arms	1	419	24	168	225	477	210.00	100.98	344.48	20.79	10.00	83.54
125	Skin, legs	77	343	1	205	1	289	209.49	136.90	152.66	20.74	13.55	37.02
126	Spinal cord	202	218	129	203	304	511	208.65	168.55	394.38	20.66	16.69	95.64
127	Spleen	252	318	111	182	387	412	295.72	150.63	399.04	29.28	14.91	96.77
128	Teeth	176	245	28	72	504	516	210.25	51.65	509.62	20.81	5.11	123.58
	Testes												
129	Testis, left	211	220	100	111	267	272	214.87	104.74	268.97	21.27	10.37	65.23
130	Testis, right	200	209	100	111	267	272	204.11	104.75	268.97	20.21	10.37	65.23
131	Thymus	191	229	73	120	451	475	207.99	101.91	461.62	20.59	10.09	111.94
132	Thyroid	189	234	86	105	478	491	210.78	93.58	484.01	20.87	9.26	117.37
133	Tongue (inner part)	193	228	46	98	497	513	209.72	75.47	505.58	20.76	7.47	122.60
134	Tonsils	190	231	101	112	505	511	209.82	106.07	507.37	20.77	10.50	123.04
	Ureters												
135	Ureter, left	219	238	112	174	305	378	230.05	136.52	340.09	22.77	13.52	82.47
136	Ureter, right	182	201	112	174	305	378	188.87	139.72	340.98	18.70	13.83	82.69
137	Urinary bladder wall	172	248	101	153	283	306	209.49	126.92	293.82	20.74	12.56	71.25
138	Urinary bladder contents	175	245	103	152	284	305	209.50	126.78	294.12	20.74	12.55	71.32
139	Uterus and cervix												
140	Air inside the body	176	282	12	146	401	541	234.30	102.14	448.13	23.20	10.11	108.67

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918 Table A.9. ID listings, rectangular prism (box) containing the organ (minimum/maximum
 919 columns, rows, and slices occupied by each organ/tissue), and organs centres of mass (in terms of
 920 voxels as well as co-ordinates) for the *10-year-old female phantom*.

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
Adrenals													
1	Adrenal gland, left	228	250	158	181	395	405	237.56	167.66	399.39	23.52	16.60	96.85
2	Adrenal gland, right	166	188	157	185	390	399	176.30	170.20	394.04	17.45	16.85	95.56
Airways (and mouth)													
3	Anterior nasal passage (ET ₁)	203	219	11	21	521	529	210.91	16.07	522.21	20.88	1.59	126.64
4	Posterior nasal passage (ET ₂)	175	245	21	115	499	541	208.97	66.49	522.76	20.69	6.58	126.77
5	Oral mucosa, tongue	193	225	46	96	499	513	209.81	70.95	511.54	20.77	7.02	124.05
6	Oral mucosa, lips & cheeks	185	236	22	38	508	514	209.65	27.88	510.59	20.76	2.76	123.82
7	Trachea	204	216	108	131	460	485	209.26	118.61	471.55	20.72	11.74	114.35
8	Bronchi	191	229	122	135	448	459	212.57	128.34	452.28	21.04	12.71	109.68
Blood vessels													
9	Blood vessels, head	97	323	125	154	476	513	209.50	134.85	489.33	20.74	13.35	118.66
10	Blood vessels, trunk	194	224	124	147	390	483	209.25	138.91	439.44	20.72	13.75	106.56
11	Blood vessels, arms	7	413	82	153	291	468	209.50	105.28	378.63	20.74	10.42	91.82
12	Blood vessels, legs	111	309	113	174	39	282	209.50	136.96	164.33	20.74	13.56	39.85
Bones:													
Arm bones:													
13	Humeri, proximal end, cortical bone	49	371	108	146	423	476	209.50	124.07	455.05	20.74	12.28	110.35
14	Humeri, upper half, spongiosa	62	358	110	188	457	550	209.52	125.84	466.05	20.74	12.46	113.02
15	Humeri, upper half, medullary cavity	53	367	103	128	423	485	209.51	120.85	441.12	20.74	11.96	106.97
16	Humeri, lower half, cortical bone	12	408	93	128	364	423	209.50	114.43	389.46	20.74	11.33	94.44
17	Humeri, lower half, spongiosa	17	403	99	120	364	387	209.50	110.11	374.50	20.74	10.90	90.82
18	Humeri, lower half, medullary cavity	38	382	113	125	387	423	209.50	119.17	404.76	20.74	11.80	98.15
19	Ulnae and radii, cortical bone	10	410	65	127	283	374	209.50	99.07	331.86	20.74	9.81	80.48
20	Ulnae and radii, spongiosa	14	406	69	123	285	374	209.50	102.21	340.14	20.74	10.12	82.48
21	Ulnae and radii, medullary cavity	15	405	73	120	297	356	208.84	98.00	328.63	20.68	9.70	79.69
22	Wrists and hand bones, cortical bone	9	411	28	113	227	284	209.50	74.13	260.34	20.74	7.34	63.13
23	Wrists and hand bones, spongiosa	10	410	30	113	226	284	209.50	73.59	264.19	20.74	7.29	64.07
Clavicles													
24	Clavicles, cortical bone	85	335	83	124	463	479	209.50	103.28	473.02	20.74	10.22	114.71
25	Clavicles, spongiosa	86	334	84	123	463	478	209.50	100.10	472.51	20.74	9.91	114.58
Cranium													
26	Cranium, cortical bone	137	280	20	201	510	573	208.72	110.38	539.48	20.66	10.93	130.82
27	Cranium, spongiosa	138	279	20	200	511	573	209.37	116.19	544.03	20.73	11.50	131.93
Leg bones:													
28	Femora proximal end, cortical bone	93	327	119	162	203	293	209.50	141.85	255.89	20.74	14.04	62.05
29	Femora upper half, spongiosa	97	323	123	157	265	292	209.50	138.35	278.30	20.74	13.70	67.49
30	Femora upper half, medullary cavity	111	309	140	150	203	264	209.50	144.14	233.87	20.74	14.27	56.71
31	Femora lower half, cortical bone	119	301	126	178	150	202	209.50	148.03	169.52	20.74	14.66	41.11
32	Femora lower half, spongiosa	122	298	131	169	151	170	209.50	148.44	159.00	20.74	14.70	38.56
33	Femora lower half, medullary cavity	130	290	140	150	170	202	209.50	144.70	183.70	20.74	14.33	44.55
34	Tibiae, fibulae, and patellae, cortical bone	120	300	114	175	27	164	209.50	148.33	99.10	20.74	14.69	24.03
35	Tibiae, fibulae, and patellae, spongiosa	125	295	114	173	28	164	209.50	142.76	124.70	20.74	14.13	30.24
36	Tibiae, fibulae, and patellae, medullary cavity	131	289	137	168	47	128	209.50	147.39	90.19	20.74	14.59	21.87
37	Ankles and foot bones, cortical bone	126	294	4	186	4	32	209.49	111.86	16.34	20.74	11.07	3.96
38	Ankles and foot bones, spongiosa	126	294	7	185	5	32	209.50	130.14	18.06	20.74	12.88	4.38
39	Mandible, cortical bone	158	262	25	103	501	524	209.92	66.86	508.91	20.78	6.62	123.41
40	Mandible, spongiosa	160	260	26	102	501	523	208.60	63.98	507.23	20.65	6.33	123.00

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923 Table A.9. (continued – 10-year-old female phantom)

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
Pelvis													
41	Pelvis, cortical bone	98	324	86	185	267	340	210.54	137.67	305.49	20.84	13.63	74.08
42	Pelvis, spongiosa	99	323	87	184	268	339	210.70	138.98	303.74	20.86	13.76	73.66
Ribs													
43	Ribs, cortical bone	89	331	49	201	361	479	209.50	142.19	424.47	20.74	14.08	102.93
44	Ribs, spongiosa	90	330	50	201	361	479	209.50	141.11	426.25	20.74	13.97	103.37
Scapulae													
45	Scapulae, cortical bone	66	354	135	202	429	480	209.50	178.13	459.70	20.74	17.64	111.48
46	Scapulae, spongiosa	67	353	136	201	430	479	209.50	171.92	462.50	20.74	17.02	112.16
Spine													
47	Cervical spine, cortical bone	178	242	114	174	480	512	208.40	135.77	496.02	20.63	13.44	120.28
48	Cervical spine, spongiosa	179	241	114	173	480	512	208.56	133.75	496.42	20.65	13.24	120.38
49	Thoracic spine, cortical bone	176	240	133	206	374	480	207.01	170.55	429.04	20.49	16.88	104.04
50	Thoracic spine, spongiosa	177	239	133	206	375	480	207.46	168.37	427.59	20.54	16.67	103.69
51	Lumbar spine, cortical bone	178	245	127	202	321	378	209.64	159.93	348.88	20.75	15.83	84.60
52	Lumbar spine, spongiosa	179	243	128	202	321	378	209.96	155.06	348.49	20.79	15.35	84.51
Sacrum													
53	Sacrum, cortical bone	177	245	149	211	288	327	209.97	181.60	309.86	20.79	17.98	75.14
54	Sacrum, spongiosa	178	244	149	211	288	326	209.60	173.59	312.68	20.75	17.19	75.83
Sternum													
55	Sternum, cortical bone	190	232	43	93	425	467	209.92	65.16	449.59	20.78	6.45	109.03
56	Sternum, spongiosa	191	231	43	92	425	467	210.22	67.42	451.59	20.81	6.67	109.51
Cartilage													
57	Cartilage, head	127	293	7	117	484	536	209.69	76.09	507.04	20.76	7.53	122.96
58	Cartilage, trunk	109	311	37	188	318	550	209.13	114.43	397.03	20.70	11.33	96.28
59	Cartilage, arms												
60	Cartilage, legs												
61	Brain	143	273	37	194	511	570	208.92	122.59	543.11	20.68	12.14	131.71
Breasts													
62	Breast, left, adipose tissue	260	285	16	28	421	431	272.03	21.50	425.41	26.93	2.13	103.16
63	Breast, left, glandular tissue	265	281	18	27	423	429	272.31	21.57	425.50	26.96	2.14	103.18
64	Breast, right, adipose tissue	135	160	16	28	421	431	146.98	21.50	425.41	14.55	2.13	103.16
65	Breast, right, glandular tissue	139	155	18	27	423	429	146.69	21.57	425.50	14.52	2.14	103.18
Eyes													
66	Eye lens, left	233	241	35	38	532	535	236.29	36.28	532.71	23.39	3.59	129.18
67	Eye bulb, left	225	248	33	55	529	537	235.91	43.99	532.77	23.35	4.36	129.20
68	Eye lens, right	179	187	35	38	532	535	182.71	36.28	532.71	18.09	3.59	129.18
69	Eye bulb, right	172	195	33	55	529	537	183.09	43.99	532.77	18.13	4.36	129.20
Gallbladder													
70	Gallbladder wall	130	172	87	128	379	396	149.83	105.29	387.06	14.83	10.42	93.86
71	Gallbladder contents	131	172	89	127	379	395	149.99	106.72	387.49	14.85	10.57	93.97
Gastrointestinal tract													
72	Stomach wall	198	292	55	150	377	410	254.84	97.67	393.15	25.23	9.67	95.34
73	Stomach contents	199	286	62	145	378	400	251.83	95.98	390.93	24.93	9.50	94.80
74	Small intestine wall	115	310	56	132	311	392	207.56	94.94	347.04	20.55	9.40	84.16
75	Small intestine contents	118	306	59	129	315	388	206.91	95.32	347.01	20.48	9.44	84.15
76	Ascending colon wall	111	148	54	132	308	373	127.92	103.02	343.24	12.66	10.20	83.23
77	Ascending colon contents	117	144	59	127	308	371	128.07	102.99	343.15	12.68	10.20	83.21

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926 Table A.9. (continued – 10-year-old female phantom)

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
78	Transverse colon wall, right	140	205	42	74	340	373	172.92	54.55	356.72	17.12	5.40	86.50
79	Transverse colon content, right	142	205	47	69	342	371	172.86	54.63	356.78	17.11	5.41	86.52
80	Transverse colon wall, left	206	297	40	86	340	380	242.53	56.34	361.32	24.01	5.58	87.62
81	Transverse colon content, left	206	295	45	81	342	378	242.39	56.36	361.20	24.00	5.58	87.59
82	Descending colon wall, left	277	315	66	116	338	375	297.94	93.37	355.61	29.50	9.24	86.24
83	Descending colon content, left	281	310	71	111	338	373	297.47	93.36	355.52	29.45	9.24	86.21
84	Sigmoid colon wall	171	295	96	170	285	340	228.38	135.18	313.95	22.61	13.38	76.13
85	Sigmoid colon content	174	292	99	167	272	340	232.90	130.85	316.44	23.06	12.95	76.74
86	Rectum wall	200	213	156	170	272	284	205.29	162.43	277.57	20.32	16.08	67.31
Heart													
87	Heart wall	170	267	49	138	416	454	215.10	92.40	431.72	21.30	9.15	104.69
88	Heart chamber contents (blood)	180	264	54	132	419	453	218.70	91.45	432.74	21.65	9.05	104.94
Kidneys													
89	Kidney, left, cortex	232	285	146	185	361	399	259.39	165.54	379.59	25.68	16.39	92.05
90	Kidney, left, medulla	239	274	153	179	368	393	256.88	165.82	379.55	25.43	16.42	92.04
91	Kidney, left, pelvis	244	263	159	173	374	386	253.41	165.94	379.46	25.09	16.43	92.02
92	Kidney, right cortex	132	185	146	185	355	393	156.74	165.53	373.55	15.52	16.39	90.59
93	Kidney, right medulla	143	178	153	179	362	387	159.21	165.81	373.52	15.76	16.42	90.58
94	Kidney, right pelvis	154	173	159	173	367	380	162.68	165.95	373.44	16.11	16.43	90.56
95	Liver	103	274	45	191	363	420	163.58	108.45	400.19	16.19	10.74	97.05
Lungs													
96	Lung, left, blood	249	301	80	160	423	473	270.70	137.51	441.68	26.80	13.61	107.11
97	Lung, left, air-filled tissue	216	306	65	184	413	477	261.65	134.51	444.91	25.90	13.32	107.89
98	Lung, right blood	119	185	81	169	425	471	162.37	129.69	441.29	16.07	12.84	107.01
99	Lung, right air-filled tissue	104	205	64	188	416	475	155.73	126.53	441.98	15.42	12.53	107.18
Lymphatic nodes													
100	Lymphatic nodes, ET airways	168	250	81	160	453	522	208.49	115.66	499.10	20.64	11.45	121.03
101	Lymphatic nodes, thoracic airways	167	251	119	199	369	499	208.50	159.18	423.00	20.64	15.76	102.58
102	Lymphatic nodes, head	168	250	112	176	478	502	208.50	144.66	486.13	20.64	14.32	117.89
103	Lymphatic nodes, trunk	50	368	21	195	273	465	208.50	134.04	346.69	20.64	13.27	84.07
104	Lymphatic nodes, arms	12	406	86	135	329	417	208.50	114.53	378.66	20.64	11.34	91.83
105	Lymphatic nodes, legs	118	300	138	183	221	314	208.50	158.63	261.08	20.64	15.70	63.31
Muscle (skeletal)													
106	Muscle, head	140	281	22	203	497	575	210.91	96.21	526.31	20.88	9.52	127.63
107	Muscle, trunk	54	366	19	217	262	511	209.68	121.55	393.05	20.76	12.03	95.32
108	Muscle, arms	3	417	25	155	225	477	209.51	106.70	361.27	20.74	10.56	87.61
109	Muscle, legs	89	331	2	192	2	290	209.48	138.15	177.34	20.74	13.68	43.01
110	Oesophagus wall	203	231	114	145	401	494	211.55	134.73	447.68	20.94	13.34	108.56
Ovaries													
111	Ovary, left	225	239	121	133	305	311	231.33	126.41	307.79	22.90	12.52	74.64
112	Ovary, right	181	195	121	133	305	311	187.67	126.41	307.79	18.58	12.52	74.64
113	Pancreas	182	298	101	145	375	389	236.07	123.35	381.65	23.37	12.21	92.55
114	Pituitary gland	206	214	83	90	537	540	209.50	86.21	538.07	20.74	8.53	130.48
115	Prostate												
Residual tissue													
116	Residual tissue, head	137	283	18	207	496	575	210.15	111.57	538.37	20.80	11.05	130.56
117	Residual tissue, trunk	52	367	18	225	266	511	212.04	128.50	383.05	20.99	12.72	92.89
118	Residual tissue, arms	2	418	71	168	301	477	208.55	123.77	420.41	20.65	12.25	101.95

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929 Table A.9. (continued – *10-year-old female phantom*)

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
119	Residual tissue, legs	78	342	47	204	2	290	209.54	140.28	216.57	20.74	13.89	52.52
	Salivary glands												
120	Salivary glands, left	212	265	46	120	498	518	241.72	95.57	506.40	23.93	9.46	122.80
121	Salivary glands, right	155	208	46	120	498	518	177.28	95.57	506.40	17.55	9.46	122.80
	Skin												
122	Skin, head	126	294	6	208	496	576	209.54	108.86	536.97	20.74	10.78	130.22
123	Skin, trunk	50	368	15	226	10	510	209.58	125.30	385.45	20.75	12.40	93.47
124	Skin, arms	1	419	24	168	225	477	209.99	100.98	344.48	20.79	10.00	83.54
125	Skin, legs	77	343	1	205	1	289	209.49	136.90	152.67	20.74	13.55	37.02
126	Spinal cord	202	218	129	203	304	511	208.65	168.55	394.39	20.66	16.69	95.64
127	Spleen	252	318	111	182	387	412	295.72	150.63	399.04	29.28	14.91	96.77
128	Teeth	176	245	28	72	504	516	210.25	51.65	509.62	20.81	5.11	123.58
	Testes												
129	Testis, left												
130	Testis, right												
131	Thymus	191	229	73	120	451	475	207.99	101.91	461.62	20.59	10.09	111.94
132	Thyroid	189	234	86	105	478	491	210.80	93.56	484.01	20.87	9.26	117.37
133	Tongue (inner part)	193	228	46	98	497	513	209.72	75.47	505.58	20.76	7.47	122.60
134	Tonsils	190	231	101	112	505	511	209.78	106.05	507.37	20.77	10.50	123.04
	Ureters												
135	Ureter, left	219	238	112	174	305	378	230.05	136.52	340.09	22.77	13.52	82.47
136	Ureter, right	182	201	112	174	305	378	188.87	139.72	340.98	18.70	13.83	82.69
137	Urinary bladder wall	174	246	86	140	285	310	209.58	112.74	296.57	20.75	11.16	71.92
138	Urinary bladder contents	176	244	88	138	286	308	209.56	112.31	296.69	20.75	11.12	71.95
139	Uterus and cervix	196	222	124	143	300	309	208.99	133.71	305.07	20.69	13.24	73.98
140	Air inside the body	176	282	12	145	401	541	234.30	102.12	448.15	23.20	10.11	108.68

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932 Table A.10. ID listings, rectangular prism (box) containing the organ (minimum/maximum
 933 columns, rows, and slices occupied by each organ/tissue), and organs centres of mass (in terms of
 934 voxels as well as co-ordinates) for the *15-year-old male phantom*.

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
Adrenals													
1	Adrenal gland, left	230	250	140	161	399	410	238.38	148.37	403.95	29.80	18.55	114.40
2	Adrenal gland, right	155	174	150	170	397	406	164.96	158.30	401.47	20.62	19.79	113.70
Airways (and mouth)													
3	Anterior nasal passage (ET ₁)	198	210	48	65	539	548	203.31	58.07	541.85	25.41	7.26	153.45
4	Posterior nasal passage (ET ₂)	175	234	64	134	512	560	204.07	93.81	539.02	25.51	11.73	152.65
5	Oral mucosa, tongue	188	220	77	126	513	532	203.62	103.74	521.88	25.45	12.97	147.80
6	Oral mucosa, lips & cheeks	182	226	61	76	524	530	203.91	66.42	526.53	25.49	8.30	149.11
7	Trachea	199	209	117	140	475	496	203.44	128.65	484.66	25.43	16.08	137.26
8	Bronchi	184	224	130	141	462	474	204.68	135.09	467.02	25.58	16.89	132.26
Blood vessels													
9	Blood vessels, head	99	309	133	181	486	534	203.61	148.46	504.22	25.45	18.56	142.80
10	Blood vessels, trunk	189	221	125	148	407	497	205.05	139.82	455.96	25.63	17.48	129.13
11	Blood vessels, arms	11	397	108	183	297	482	203.50	134.64	387.78	25.44	16.83	109.82
12	Blood vessels, legs	107	301	123	188	44	302	203.50	148.16	175.66	25.44	18.52	49.75
Bones:													
Arm bones:													
13	Humeri, proximal end, cortical bone	52	356	136	178	433	488	203.50	152.85	458.79	25.44	19.11	129.93
14	Humeri, upper half, spongiosa	59	349	137	177	282	487	203.46	156.07	474.68	25.43	19.51	134.43
15	Humeri, upper half, medullary cavity	57	351	106	157	312	542	203.52	150.60	450.92	25.44	18.82	127.70
16	Humeri, lower half, cortical bone	13	395	120	158	371	433	203.50	144.30	399.29	25.44	18.04	113.08
17	Humeri, lower half, spongiosa	22	386	123	151	371	395	203.50	138.21	381.71	25.44	17.28	108.10
18	Humeri, lower half, medullary cavity	44	364	145	154	395	432	203.50	149.06	412.85	25.44	18.63	116.92
19	Ulnae and radii, cortical bone	12	396	88	157	286	382	203.50	126.82	336.44	25.44	15.85	95.28
20	Ulnae and radii, spongiosa	14	394	89	156	286	381	203.50	127.06	341.02	25.44	15.88	96.58
21	Ulnae and radii, medullary cavity	20	388	100	148	301	362	203.50	126.51	334.00	25.44	15.81	94.59
22	Wrists and hand bones, cortical bone	16	392	48	143	227	287	203.49	98.88	262.49	25.44	12.36	74.34
23	Wrists and hand bones, spongiosa	17	391	49	141	228	287	203.50	98.20	267.32	25.44	12.28	75.71
Clavicles													
24	Clavicles, cortical bone	76	329	92	170	483	492	202.02	130.80	488.28	25.25	16.35	138.28
25	Clavicles, spongiosa	78	327	94	168	484	491	201.38	127.62	488.10	25.17	15.95	138.23
Cranium													
26	Cranium, cortical bone	146	260	56	207	526	585	203.57	129.90	553.48	25.45	16.24	156.75
27	Cranium, spongiosa	147	259	58	206	527	585	202.88	138.78	554.97	25.36	17.35	157.17
Leg bones:													
28	Femora proximal end, cortical bone	86	322	124	171	216	312	203.49	150.79	262.80	25.44	18.85	74.42
29	Femora upper half, spongiosa	87	321	126	170	282	312	203.52	145.88	296.74	25.44	18.24	84.04
30	Femora upper half, medullary cavity	105	303	149	160	216	281	203.50	153.80	248.96	25.44	19.23	70.50
31	Femora lower half, cortical bone	104	304	137	193	159	215	203.50	157.61	187.69	25.44	19.70	53.15
32	Femora lower half, spongiosa	106	302	136	191	159	180	203.50	162.10	168.71	25.44	20.26	47.78
33	Femora lower half, medullary cavity	123	285	150	161	181	215	203.50	155.40	195.54	25.44	19.43	55.38
34	Tibiae, fibulae, and patellae, cortical bone	104	304	123	190	29	175	203.50	159.91	107.80	25.44	19.99	30.53
35	Tibiae, fibulae, and patellae, spongiosa	107	301	125	189	29	174	203.50	158.82	118.98	25.44	19.85	33.70
36	Tibiae, fibulae, and patellae, medullary cavity	116	292	150	183	51	136	203.50	158.96	95.88	25.44	19.87	27.15
37	Ankles and foot bones, cortical bone	102	306	3	202	5	35	203.50	119.43	17.46	25.44	14.93	4.95
38	Ankles and foot bones, spongiosa	103	305	5	201	5	35	203.50	139.55	19.34	25.44	17.44	5.48
39	Mandible, cortical bone	161	248	63	130	515	542	203.42	97.29	525.32	25.43	12.16	148.77
40	Mandible, spongiosa	163	246	66	128	516	541	202.70	93.74	522.84	25.34	11.72	148.07

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937 Table A.10. (continued – 15-year-old male phantom)

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
Pelvis													
41	Pelvis, cortical bone	99	309	96	189	285	358	203.55	144.33	322.75	25.44	18.04	91.40
42	Pelvis, spongiosa	100	308	97	188	285	358	203.50	145.84	321.93	25.44	18.23	91.17
Ribs													
43	Ribs, cortical bone	86	322	55	203	381	502	203.50	148.61	444.73	25.44	18.58	125.95
44	Ribs, spongiosa	86	322	56	202	382	502	203.51	148.15	445.00	25.44	18.52	126.03
Scapulae													
45	Scapulae, cortical bone	76	332	150	210	434	489	203.51	188.85	467.25	25.44	23.61	132.33
46	Scapulae, spongiosa	77	331	151	210	434	489	203.50	184.18	470.04	25.44	23.02	133.12
Spine													
47	Cervical spine, cortical bone	176	233	132	179	501	531	202.73	148.57	516.02	25.34	18.57	146.14
48	Cervical spine, spongiosa	177	233	132	179	501	531	203.09	147.17	516.21	25.39	18.40	146.19
49	Thoracic spine, cortical bone	175	229	141	212	400	502	203.70	178.87	450.31	25.46	22.36	127.53
50	Thoracic spine, spongiosa	176	228	142	212	400	501	203.66	176.25	448.35	25.46	22.03	126.97
51	Lumbar spine, cortical bone	172	234	148	208	349	405	203.15	175.07	375.06	25.39	21.88	106.22
52	Lumbar spine, spongiosa	171	233	148	208	349	405	203.25	170.66	375.05	25.41	21.33	106.21
Sacrum													
53	Sacrum, cortical bone	172	236	156	210	307	350	204.22	183.63	333.67	25.53	22.95	94.50
54	Sacrum, spongiosa	173	234	157	209	307	349	204.25	179.30	335.30	25.53	22.41	94.96
Sternum													
55	Sternum, cortical bone	181	227	48	110	429	487	202.88	80.56	463.12	25.36	10.07	131.16
56	Sternum, spongiosa	181	225	49	109	430	487	202.05	83.76	466.27	25.26	10.47	132.05
Cartilage													
57	Cartilage, head	134	274	47	142	495	553	203.49	112.81	516.70	25.44	14.10	146.33
58	Cartilage, trunk	108	300	49	186	349	553	203.75	113.99	429.99	25.47	14.25	121.77
59	Cartilage, arms												
60	Cartilage, legs												
Brain													
61	Brain	151	256	72	200	531	582	203.24	141.61	558.28	25.41	17.70	158.11
Breasts													
62	Breast, left, adipose tissue	262	288	40	52	428	438	274.59	45.19	432.24	34.32	5.65	122.41
63	Breast, left, glandular tissue	267	284	42	50	429	436	274.71	45.47	432.14	34.34	5.68	122.38
64	Breast, right, adipose tissue	120	146	40	52	428	438	132.37	44.36	432.29	16.55	5.55	122.42
65	Breast, right, glandular tissue	124	141	44	53	429	436	132.35	47.84	432.01	16.54	5.98	122.34
Eyes													
66	Eye lens, left	223	231	69	70	548	551	226.79	68.99	549.19	28.35	8.62	155.53
67	Eye bulb, left	218	236	67	84	546	553	226.73	75.56	548.92	28.34	9.44	155.45
68	Eye lens, right	177	185	69	70	548	551	180.21	68.99	549.19	22.53	8.62	155.53
69	Eye bulb, right	172	190	67	84	546	553	180.27	75.56	548.92	22.53	9.44	155.45
Gallbladder													
70	Gallbladder wall	169	209	86	126	388	403	185.57	102.83	395.41	23.20	12.85	111.98
71	Gallbladder contents	170	208	87	125	388	402	185.72	103.88	394.60	23.22	12.98	111.75
Gastrointestinal tract													
72	Stomach wall	192	296	68	145	374	423	248.39	104.55	397.17	31.05	13.07	112.48
73	Stomach contents	195	292	70	130	375	393	240.65	97.08	385.83	30.08	12.14	109.27
74	Small intestine wall	119	304	73	158	310	398	202.98	116.46	349.74	25.37	14.56	99.05
75	Small intestine contents	122	302	76	155	311	397	203.12	116.51	349.45	25.39	14.56	98.96
76	Ascending colon wall	116	153	65	132	312	369	132.62	108.08	343.09	16.58	13.51	97.16
77	Ascending colon contents	121	149	70	128	313	367	132.89	108.00	343.07	16.61	13.50	97.16

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940 Table A.10. (continued – 15-year-old male phantom)

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
78	Transverse colon wall, right	143	204	57	88	338	369	174.35	72.00	354.77	21.79	9.00	100.47
79	Transverse colon content, right	144	204	61	84	340	367	174.46	72.09	354.71	21.81	9.01	100.45
80	Transverse colon wall, left	203	284	56	104	338	379	233.77	74.33	361.27	29.22	9.29	102.31
81	Transverse colon content, left	204	282	60	100	340	377	233.91	74.57	361.46	29.24	9.32	102.36
82	Descending colon wall, left	267	304	82	126	337	377	287.41	107.78	356.81	35.93	13.47	101.05
83	Descending colon content, left	271	300	86	122	340	373	287.22	108.41	356.52	35.90	13.55	100.97
84	Sigmoid colon wall	166	285	105	187	291	341	217.23	162.28	314.27	27.15	20.29	89.00
85	Sigmoid colon content	168	284	106	184	283	340	229.74	148.09	320.90	28.72	18.51	90.88
86	Rectum wall	197	221	163	179	282	294	206.89	169.75	287.90	25.86	21.22	81.53
Heart													
87	Heart wall	178	267	63	142	424	472	220.48	101.00	445.72	27.56	12.62	126.23
88	Heart chamber contents (blood)	183	262	69	133	425	471	219.54	100.69	446.25	27.44	12.59	126.38
Kidneys													
89	Kidney, left, cortex	223	270	147	178	360	402	245.93	163.22	380.56	30.74	20.40	107.78
90	Kidney, left, medulla	234	263	152	175	373	400	248.23	163.49	387.06	31.03	20.44	109.62
91	Kidney, left, pelvis	240	255	157	170	381	394	247.70	163.50	387.63	30.96	20.44	109.78
92	Kidney, right cortex	137	184	155	186	358	400	159.21	171.18	380.04	19.90	21.40	107.63
93	Kidney, right medulla	146	175	158	181	368	394	159.18	170.02	381.51	19.90	21.25	108.04
94	Kidney, right pelvis	153	168	163	177	375	389	159.72	169.96	382.11	19.97	21.25	108.21
95	Liver	98	258	56	152	369	426	159.92	95.35	403.90	19.99	11.92	114.39
Lungs													
96	Lung, left, blood	244	297	106	169	436	488	263.96	148.19	455.70	33.00	18.52	129.05
97	Lung, left, air-filled tissue	218	309	75	188	415	494	262.90	143.56	453.38	32.86	17.94	128.40
98	Lung, right blood	120	178	87	163	437	485	156.90	129.78	454.75	19.61	16.22	128.79
99	Lung, right air-filled tissue	101	194	70	183	422	492	148.09	130.26	452.59	18.51	16.28	128.17
Lymphatic nodes													
100	Lymphatic nodes, ET airways	167	239	85	157	473	539	202.50	119.14	516.91	25.31	14.89	146.39
101	Lymphatic nodes, thoracic airways	168	238	101	171	363	518	202.50	140.88	425.91	25.31	17.61	120.62
102	Lymphatic nodes, head	160	246	115	141	496	538	202.50	128.74	507.30	25.31	16.09	143.67
103	Lymphatic nodes, trunk	77	329	43	193	234	494	202.50	137.19	358.51	25.31	17.15	101.53
104	Lymphatic nodes, arms	25	381	107	146	328	434	202.50	123.91	373.84	25.31	15.49	105.87
105	Lymphatic nodes, legs	115	291	121	148	128	218	202.50	131.03	183.47	25.31	16.38	51.96
Muscle (skeletal)													
106	Muscle, head	146	262	61	207	511	585	204.15	124.23	537.21	25.52	15.53	152.14
107	Muscle, trunk	32	388	41	220	249	522	203.68	142.98	412.28	25.46	17.87	116.76
108	Muscle, arms	7	401	45	180	226	489	203.50	132.10	371.27	25.44	16.51	105.14
109	Muscle, legs	78	330	2	209	2	312	203.48	149.71	184.32	25.44	18.71	52.20
110	Oesophagus wall	198	227	124	148	412	506	206.19	140.16	458.52	25.77	17.52	129.85
Ovaries													
111	Ovary, left												
112	Ovary, right												
113	Pancreas	181	289	112	150	374	394	236.63	133.10	382.74	29.58	16.64	108.39
114	Pituitary gland	201	208	110	117	551	554	203.98	112.80	551.79	25.50	14.10	156.27
115	Prostate	194	213	144	157	283	290	203.57	149.93	286.38	25.45	18.74	81.10
Residual tissue													
116	Residual tissue, head	145	263	60	207	511	585	203.44	128.40	541.78	25.43	16.05	153.43
117	Residual tissue, trunk	35	372	36	224	278	523	203.93	137.91	394.72	25.49	17.24	111.78
118	Residual tissue, arms	2	406	97	187	312	489	203.01	145.40	414.27	25.38	18.18	117.32

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942 Table A.10. (continued – *15-year-old male phantom*)

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
119	Residual tissue, legs	72	336	81	207	51	311	203.27	139.45	238.88	25.41	17.43	67.65
	Salivary glands												
120	Salivary glands, left	205	258	80	140	517	539	232.80	118.53	526.18	29.10	14.82	149.01
121	Salivary glands, right	150	236	80	172	517	539	174.33	118.73	526.13	21.79	14.84	149.00
	Skin												
122	Skin, head	133	275	46	208	511	586	203.52	130.76	549.55	25.44	16.35	155.63
123	Skin, trunk	33	389	35	225	249	522	203.57	135.80	400.45	25.45	16.97	113.41
124	Skin, arms	1	407	44	187	226	486	203.88	125.21	342.02	25.48	15.65	96.86
125	Skin, legs	71	337	1	210	1	305	203.52	147.79	156.37	25.44	18.47	44.28
126	Spinal cord	197	211	143	191	349	533	203.69	170.45	446.29	25.46	21.31	126.39
127	Spleen	255	310	104	186	386	417	289.40	151.36	401.32	36.17	18.92	113.65
128	Teeth	179	232	66	101	522	531	204.45	81.85	525.90	25.56	10.23	148.93
	Testes												
129	Testis, left	205	220	111	129	280	290	212.03	119.56	284.92	26.50	14.94	80.69
130	Testis, right	188	203	111	129	280	290	195.02	119.57	284.92	24.38	14.95	80.69
131	Thymus	188	220	100	133	472	489	203.84	116.88	478.41	25.48	14.61	135.49
132	Thyroid	186	224	105	125	489	502	203.99	112.62	495.30	25.50	14.08	140.27
133	Tongue (inner part)	189	219	77	125	514	531	203.52	104.30	522.01	25.44	13.04	147.83
134	Tonsils	188	220	121	130	519	524	203.50	125.19	520.80	25.44	15.65	147.49
	Ureters												
135	Ureter, left	212	234	145	167	317	378	224.44	155.61	347.73	28.06	19.45	98.48
136	Ureter, right	174	196	154	167	316	378	182.27	160.86	346.42	22.78	20.11	98.11
137	Urinary bladder wall	170	238	126	170	291	317	203.59	147.23	303.59	25.45	18.40	85.98
138	Urinary bladder contents	173	235	127	169	292	316	203.48	147.37	303.53	25.44	18.42	85.96
139	Uterus and cervix												
140	Air inside the body	176	294	49	143	393	559	255.26	106.26	416.92	31.91	13.28	118.07

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945 Table A.11. ID listings, rectangular prism (box) containing the organ (minimum/maximum
 946 columns, rows, and slices occupied by each organ/tissue), and organs centres of mass (in terms of
 947 voxels as well as co-ordinates) for the *15-year-old female phantom*.

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
Adrenals													
1	Adrenal gland, left	219	240	154	176	392	401	227.70	163.38	396.32	27.32	19.61	112.08
2	Adrenal gland, right	164	184	161	181	389	397	174.60	168.81	392.70	20.95	20.26	111.06
Airways (and mouth)													
3	Anterior nasal passage (ET ₁)	195	209	50	58	524	530	201.24	53.63	524.84	24.15	6.44	148.42
4	Posterior nasal passage (ET ₂)	172	230	58	133	498	541	199.62	97.42	522.98	23.95	11.69	147.90
5	Oral mucosa, tongue	185	218	74	123	498	517	200.79	102.09	507.76	24.09	12.25	143.60
6	Oral mucosa, lips & cheeks	179	225	56	72	511	517	201.06	63.03	513.10	24.13	7.56	145.10
7	Trachea	196	207	118	144	456	481	200.73	131.13	468.28	24.09	15.74	132.43
8	Bronchi	186	223	134	147	444	455	203.77	140.25	448.53	24.45	16.83	126.85
Blood vessels													
9	Blood vessels, head	96	306	133	191	470	518	200.34	157.40	487.61	24.04	18.89	137.90
10	Blood vessels, trunk	67	335	131	165	399	481	200.50	152.07	439.87	24.06	18.25	124.39
11	Blood vessels, arms	10	392	120	185	290	462	200.50	140.57	373.99	24.06	16.87	105.77
12	Blood vessels, legs	103	299	108	191	41	295	200.50	144.20	169.92	24.06	17.30	48.05
Bones:													
Arm bones:													
13	Humeri, proximal end, cortical bone	48	354	138	178	419	473	200.50	155.21	444.05	24.06	18.62	125.58
14	Humeri, upper half, spongiosa	56	346	139	178	454	472	200.50	157.44	463.27	24.06	18.89	131.01
15	Humeri, upper half, medullary cavity	53	349	63	159	419	529	200.62	153.77	437.25	24.07	18.45	123.66
16	Humeri, lower half, cortical bone	14	388	129	163	361	419	200.50	150.58	387.80	24.06	18.07	109.67
17	Humeri, lower half, spongiosa	19	383	133	158	362	383	200.50	146.41	371.24	24.06	17.57	104.99
18	Humeri, lower half, medullary cavity	42	360	149	158	384	418	200.50	153.33	400.17	24.06	18.40	113.17
19	Ulnae and radii, cortical bone	12	390	100	164	281	371	200.48	135.32	328.16	24.06	16.24	92.80
20	Ulnae and radii, spongiosa	12	390	101	163	282	371	200.50	136.51	333.60	24.06	16.38	94.34
21	Ulnae and radii, medullary cavity	17	385	109	157	292	354	200.63	134.96	325.52	24.08	16.20	92.06
22	Wrists and hand bones, cortical bone	12	390	62	151	224	282	200.50	109.62	258.16	24.06	13.15	73.01
23	Wrists and hand bones, spongiosa	13	389	63	149	225	281	200.50	109.19	262.88	24.06	13.10	74.34
Clavicles													
24	Clavicles, cortical bone	81	321	94	182	470	477	200.50	136.90	473.62	24.06	16.43	133.94
25	Clavicles, spongiosa	84	318	96	180	470	476	200.50	135.36	473.62	24.06	16.24	133.94
Cranium													
26	Cranium, cortical bone	141	258	57	206	513	568	199.97	132.42	539.82	24.00	15.89	152.66
27	Cranium, spongiosa	142	257	58	205	513	568	200.47	135.56	543.51	24.06	16.27	153.71
Leg bones:													
28	Femora proximal end, cortical bone	83	319	106	155	228	303	200.50	136.63	265.85	24.06	16.40	75.18
29	Femora upper half, spongiosa	84	318	108	151	279	302	200.50	127.00	289.59	24.06	15.24	81.90
30	Femora upper half, medullary cavity	93	309	132	151	228	279	200.50	141.25	255.78	24.06	16.95	72.33
31	Femora lower half, cortical bone	101	301	137	194	155	227	200.50	153.93	190.06	24.06	18.47	53.75
32	Femora lower half, spongiosa	103	299	137	192	156	178	200.50	162.19	165.18	24.06	19.46	46.71
33	Femora lower half, medullary cavity	116	286	143	159	178	227	200.50	150.93	198.64	24.06	18.11	56.17
34	Tibiae, fibulae, and patellae, cortical bone	102	300	125	192	29	170	200.50	161.42	106.75	24.06	19.37	30.19
35	Tibiae, fibulae, and patellae, spongiosa	106	296	126	191	29	170	200.50	159.81	116.77	24.06	19.18	33.02
36	Tibiae, fibulae, and patellae, medullary cavity	113	289	151	183	50	134	200.50	160.87	95.22	24.06	19.30	26.93
37	Ankles and foot bones, cortical bone	107	295	4	204	5	34	200.50	122.71	17.89	24.06	14.73	5.06
38	Ankles and foot bones, spongiosa	108	294	4	203	6	34	200.50	143.09	19.76	24.06	17.17	5.59
39	Mandible, cortical bone	158	244	60	125	502	526	200.62	91.71	511.47	24.07	11.01	144.65
40	Mandible, spongiosa	160	242	64	124	502	526	199.55	86.22	509.38	23.95	10.35	144.05

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950 Table A.11. (continued – 15-year-old female phantom)

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
Pelvis													
41	Pelvis, cortical bone	97	303	75	193	277	346	199.82	130.24	312.79	23.98	15.63	88.46
42	Pelvis, spongiosa	98	302	76	192	278	346	201.24	132.05	312.60	24.15	15.85	88.40
Ribs													
43	Ribs, cortical bone	92	310	62	202	368	484	200.53	147.59	432.31	24.06	17.71	122.26
44	Ribs, spongiosa	93	309	62	201	368	484	200.52	145.81	435.11	24.06	17.50	123.05
Scapulae													
45	Scapulae, cortical bone	65	337	150	224	417	473	200.50	195.78	450.83	24.06	23.49	127.50
46	Scapulae, spongiosa	67	335	152	222	418	472	200.50	191.16	452.76	24.06	22.94	128.04
Spine													
47	Cervical spine, cortical bone	173	233	131	183	482	519	200.41	149.02	499.75	24.05	17.88	141.33
48	Cervical spine, spongiosa	174	232	131	182	482	519	200.47	147.94	500.24	24.06	17.75	141.47
49	Thoracic spine, cortical bone	173	226	142	213	386	483	200.38	179.74	437.26	24.05	21.57	123.66
50	Thoracic spine, spongiosa	173	225	143	212	386	483	200.71	176.71	431.27	24.08	21.20	121.96
51	Lumbar spine, cortical bone	168	231	128	207	334	390	200.45	162.31	363.84	24.05	19.48	102.89
52	Lumbar spine, spongiosa	166	232	128	207	334	390	200.21	158.64	360.23	24.03	19.04	101.87
Sacrum													
53	Sacrum, cortical bone	160	242	128	203	302	339	199.76	168.56	325.04	23.97	20.23	91.92
54	Sacrum, spongiosa	161	240	129	202	302	339	199.56	163.97	326.50	23.95	19.68	92.33
Sternum													
55	Sternum, cortical bone	183	219	60	105	435	473	201.90	81.83	455.88	24.23	9.82	128.92
56	Sternum, spongiosa	184	218	61	104	436	472	201.77	83.15	457.11	24.21	9.98	129.27
Cartilage													
57	Cartilage, head	129	273	49	153	482	535	200.45	116.37	504.66	24.05	13.96	142.72
58	Cartilage, trunk	112	290	53	187	335	508	200.90	105.71	416.85	24.11	12.69	117.89
59	Cartilage, arms												
60	Cartilage, legs												
61	Brain	146	253	71	200	515	565	200.06	141.32	542.52	24.01	16.96	153.42
Breasts													
62	Breast, left, adipose tissue	229	303	20	77	413	441	270.39	39.91	425.58	32.45	4.79	120.35
63	Breast, left, glandular tissue	234	299	24	74	413	442	271.12	43.62	424.64	32.53	5.23	120.09
64	Breast, right, adipose tissue	99	173	20	77	413	444	130.61	39.91	425.58	15.67	4.79	120.36
65	Breast, right, glandular tissue	103	168	24	74	413	442	129.88	43.62	424.64	15.59	5.23	120.09
Eyes													
66	Eye lens, left	219	226	67	69	533	535	222.18	67.50	533.65	26.66	8.10	150.92
67	Eye bulb, left	213	232	65	84	531	538	222.30	74.37	533.67	26.68	8.92	150.92
68	Eye lens, right	176	183	67	69	533	535	178.82	67.50	533.65	21.46	8.10	150.92
69	Eye bulb, right	170	189	65	84	531	538	178.70	74.37	533.67	21.44	8.92	150.92
Gallbladder													
70	Gallbladder wall	161	206	96	130	382	398	183.38	112.91	389.94	22.01	13.55	110.27
71	Gallbladder contents	162	205	97	129	382	398	183.13	112.77	389.99	21.98	13.53	110.29
Gastrointestinal tract													
72	Stomach wall	202	283	73	148	371	415	249.32	101.85	392.21	29.92	12.22	110.92
73	Stomach contents	205	278	77	134	372	397	242.84	101.20	386.76	29.14	12.14	109.38
74	Small intestine wall	114	293	57	168	310	396	198.71	106.88	347.38	23.84	12.83	98.24
75	Small intestine contents	117	290	60	165	311	395	199.45	106.98	347.53	23.93	12.84	98.28
76	Ascending colon wall	112	148	68	117	311	368	127.48	99.36	340.34	15.30	11.92	96.25
77	Ascending colon contents	117	143	74	112	312	366	127.79	99.25	340.20	15.33	11.91	96.21

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952 Table A.11. (continued – 15-year-old female phantom)

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
78	Transverse colon wall, right	136	193	47	90	331	368	165.00	62.87	350.36	19.80	7.54	99.08
79	Transverse colon content, right	137	193	53	84	333	366	165.06	62.93	350.33	19.81	7.55	99.07
80	Transverse colon wall, left	193	279	45	84	331	376	224.55	60.40	356.44	26.95	7.25	100.80
81	Transverse colon content, left	193	276	49	80	333	374	224.57	60.46	356.42	26.95	7.26	100.80
82	Descending colon wall, left	251	294	66	117	335	372	276.02	94.49	352.42	33.12	11.34	99.67
83	Descending colon content, left	255	289	70	112	336	370	275.54	94.14	352.49	33.06	11.30	99.69
84	Sigmoid colon wall	155	266	94	175	287	338	212.14	146.55	311.01	25.46	17.59	87.95
85	Sigmoid colon content	157	264	96	173	280	338	218.59	139.15	315.49	26.23	16.70	89.22
86	Rectum wall	192	204	147	158	280	288	196.66	151.51	283.16	23.60	18.18	80.08
Heart													
87	Heart wall	176	268	66	137	413	461	218.79	100.43	433.50	26.25	12.05	122.60
88	Heart chamber contents (blood)	184	263	71	132	416	459	218.10	100.94	434.77	26.17	12.11	122.95
Kidneys													
89	Kidney, left, cortex	221	270	155	189	358	396	246.30	172.86	378.24	29.56	20.74	106.97
90	Kidney, left, medulla	226	257	160	184	363	388	241.90	172.42	375.09	29.03	20.69	106.08
91	Kidney, left, pelvis	229	246	167	179	369	383	237.02	172.58	376.05	28.44	20.71	106.35
92	Kidney, right cortex	128	178	157	190	353	391	150.91	173.23	371.55	18.11	20.79	105.07
93	Kidney, right medulla	141	173	161	185	362	387	156.31	172.77	374.36	18.76	20.73	105.87
94	Kidney, right pelvis	151	169	168	179	369	382	159.44	172.82	375.31	19.13	20.74	106.14
95	Liver	97	254	59	178	368	418	160.96	106.92	398.73	19.32	12.83	112.76
Lungs													
96	Lung, left, blood	242	299	91	165	420	467	266.90	143.83	439.77	32.03	17.26	124.37
97	Lung, left, air-filled tissue	214	305	69	194	407	477	259.48	143.13	442.24	31.14	17.18	125.07
98	Lung, right blood	121	179	92	171	423	471	156.62	136.36	440.72	18.79	16.36	124.64
99	Lung, right air-filled tissue	102	191	64	193	414	477	147.28	131.22	442.31	17.67	15.75	125.09
Lymphatic nodes													
100	Lymphatic nodes, ET airways	158	242	84	144	475	537	199.50	112.87	505.41	23.94	13.54	142.93
101	Lymphatic nodes, thoracic airways	170	230	107	169	364	494	200.39	142.10	419.39	24.05	17.05	118.60
102	Lymphatic nodes, head	158	242	108	167	473	504	199.50	133.29	486.06	23.94	15.99	137.46
103	Lymphatic nodes, trunk	59	341	39	169	223	474	199.50	109.87	341.45	23.94	13.18	96.56
104	Lymphatic nodes, arms	28	372	124	164	324	399	199.50	136.03	353.07	23.94	16.32	99.85
105	Lymphatic nodes, legs	114	286	119	144	121	212	199.50	129.80	179.93	23.94	15.58	50.89
Muscle (skeletal)													
106	Muscle, head	143	260	61	205	493	568	201.35	122.48	519.43	24.16	14.70	146.89
107	Muscle, trunk	50	352	36	227	275	495	199.84	122.74	395.84	23.98	14.73	111.94
108	Muscle, arms	8	394	60	189	224	473	200.50	143.11	366.79	24.06	17.17	103.73
109	Muscle, legs	86	316	2	211	6	301	200.49	151.44	173.20	24.06	18.17	48.98
110	Oesophagus wall	194	234	130	155	403	491	203.81	145.81	444.87	24.46	17.50	125.81
Ovaries													
111	Ovary, left	199	239	121	141	304	455	228.42	125.33	309.01	27.41	15.04	87.39
112	Ovary, right	163	182	121	131	304	309	171.99	125.07	306.09	20.64	15.01	86.56
113	Pancreas	167	275	121	156	370	390	230.02	137.70	379.76	27.60	16.52	107.40
114	Pituitary gland	198	205	107	114	537	540	200.71	109.67	538.26	24.09	13.16	152.22
115	Prostate												
Residual tissue													
116	Residual tissue, head	139	263	58	210	493	570	200.40	129.17	536.59	24.05	15.50	151.75
117	Residual tissue, trunk	51	354	5	235	2	507	201.88	141.84	376.51	24.23	17.02	106.48
118	Residual tissue, arms	2	400	77	196	236	472	200.34	144.18	385.11	24.04	17.30	108.91

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955 Table A.11. (continued – *15-year-old female phantom*)

Organ ID	Organ / Tissue	Rectangular Prism						Center of Mass					
		Column		Row		Slice		Voxels			Coordinates (cm)		
		Min	Max	Min	Max	Min	Max	x	y	z	x	y	z
119	Residual tissue, legs	69	333	12	223	6	301	200.50	154.66	221.28	24.06	18.56	62.58
	Salivary glands												
120	Salivary glands, left	202	254	75	142	502	522	229.18	120.55	511.15	27.50	14.47	144.55
121	Salivary glands, right	148	256	75	142	502	529	171.86	120.52	511.16	20.62	14.46	144.56
	Skin												
122	Skin, head	128	274	48	211	496	571	200.51	129.91	533.59	24.06	15.59	150.90
123	Skin, trunk	49	356	4	236	2	506	200.74	133.13	381.12	24.09	15.98	107.78
124	Skin, arms	1	401	59	196	224	469	200.77	134.03	334.13	24.09	16.08	94.49
125	Skin, legs	68	334	1	224	1	295	200.49	152.30	157.46	24.06	18.28	44.53
126	Spinal cord	193	209	144	196	336	518	200.90	173.56	436.71	24.11	20.83	123.50
127	Spleen	251	302	107	184	381	410	282.63	148.17	395.44	33.92	17.78	111.83
128	Teeth	176	227	62	97	510	519	201.03	80.63	513.97	24.12	9.68	145.35
	Testes												
129	Testis, left												
130	Testis, right												
131	Thymus	185	218	98	127	461	478	200.69	114.47	467.40	24.08	13.74	132.18
132	Thyroid	182	222	107	128	477	489	200.97	115.18	482.48	24.12	13.82	136.45
133	Tongue (inner part)	185	217	75	122	499	517	200.70	102.55	507.94	24.08	12.31	143.64
134	Tonsils	186	216	123	133	509	514	200.49	127.79	510.79	24.06	15.33	144.45
	Ureters												
135	Ureter, left	208	232	125	178	307	373	223.25	147.77	340.15	26.79	17.73	96.20
136	Ureter, right	170	193	125	178	307	373	177.22	148.95	339.43	21.27	17.87	95.99
137	Urinary bladder wall	168	234	96	143	284	309	200.25	118.58	295.31	24.03	14.23	83.51
138	Urinary bladder contents	170	232	98	142	286	308	200.34	119.19	296.44	24.04	14.30	83.83
139	Uterus and cervix	181	219	127	152	293	312	200.20	141.79	303.12	24.02	17.02	85.72
140	Air inside the body	173	278	51	147	398	541	242.51	111.38	425.60	29.10	13.37	120.36

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957 **ANNEX B. LIST OF MEDIA AND THEIR ELEMENTAL COMPOSITIONS**

958 (B 1) For the purpose of radiation transport calculations, each organ/tissue must have a certain
959 elemental material composition. Therefore, a list of media has been defined that are assigned to
960 the various organ IDs as assigned in Table A.1. Tables B.1 to B.10 give the elemental composition
961 of the tissue media for the ICRP series of reference paediatric phantoms.

962 Table B.1. List of media, their elemental compositions (percent by mass), and their mass densities
 963 for the *newborn male phantom*.

Medium	H ₁	C ₆	N ₇	O ₈	Na ₁₁	Mg ₁₂	P ₁₅	S ₁₆	Cl ₁₇	K ₁₉	Ca ₂₀	Fe ₂₆	I ₅₃	Density (g/cm ³)
1	Teeth	2.2	9.5	2.9	42.1	0.0	0.7	13.7	0.0	0.0	28.9	0.0	0.0	1.650
2	Mineral bone	4.5	15.8	4.5	51.4	0.0	0.3	7.5	0.3	0.0	0.0	15.6	0.0	1.650
3	Humeri, upper half, spongiosa	7.3	23.1	4.0	52.8	0.1	0.2	4.0	0.3	0.0	0.1	8.1	0.0	1.307
4	Humeri, lower half, spongiosa	10.4	34.0	3.5	51.2	0.1	0.1	0.2	0.2	0.1	0.1	0.0	0.1	1.307
5	Ulnae and radii, spongiosa	10.4	34.0	3.5	51.2	0.1	0.1	0.2	0.2	0.1	0.1	0.0	0.1	1.307
6	Wrists and hand bones, spongiosa	10.4	34.0	3.5	51.2	0.1	0.1	0.2	0.2	0.1	0.1	0.0	0.1	1.244
7	Clavicles, spongiosa	6.9	21.8	4.1	53.0	0.1	0.2	4.5	0.3	0.0	0.1	9.1	0.0	1.257
8	Cranium, spongiosa	6.3	19.4	4.2	53.4	0.0	0.2	5.3	0.3	0.0	0.0	10.8	0.0	1.433
9	Femora upper half, spongiosa	7.3	23.1	4.0	52.8	0.1	0.2	4.0	0.3	0.0	0.1	8.1	0.0	1.307
10	Femora lower half, spongiosa	7.3	23.1	4.0	52.8	0.1	0.2	4.0	0.3	0.0	0.1	8.1	0.0	1.307
11	Tibiae, fibulae, and patellae, spongiosa	7.6	24.0	4.0	52.7	0.1	0.2	3.7	0.3	0.0	0.1	7.4	0.0	1.306
12	Ankles and foot bones, spongiosa	7.3	23.1	4.0	52.8	0.1	0.2	4.0	0.3	0.0	0.1	8.1	0.0	1.244
13	Mandible, spongiosa	7.9	25.3	3.9	52.5	0.1	0.2	3.2	0.2	0.0	0.1	6.5	0.1	1.244
14	Pelvis, spongiosa	7.3	23.1	4.0	52.8	0.1	0.2	4.0	0.3	0.0	0.1	8.1	0.0	1.257
15	Ribs, spongiosa	7.9	25.2	3.9	52.5	0.1	0.2	3.3	0.3	0.0	0.1	6.5	0.0	1.244
16	Scapulae, spongiosa	7.1	22.2	4.1	52.9	0.1	0.2	4.3	0.3	0.0	0.1	8.8	0.0	1.257
17	Cervical spine, spongiosa	7.9	25.3	3.9	52.5	0.1	0.2	3.2	0.2	0.0	0.1	6.5	0.1	1.338
18	Thoracic spine, spongiosa	7.8	24.8	3.9	52.5	0.1	0.2	3.4	0.3	0.0	0.1	6.8	0.0	1.351
19	Lumbar spine, spongiosa	7.8	24.8	3.9	52.5	0.1	0.2	3.4	0.3	0.0	0.1	6.8	0.0	1.307
20	Scarum, spongiosa	7.8	24.8	3.9	52.5	0.1	0.2	3.4	0.3	0.0	0.1	6.8	0.0	1.307
21	Sternum, spongiosa	7.3	23.1	4.0	52.8	0.1	0.2	4.0	0.3	0.0	0.1	8.1	0.0	1.245
22	Humeri and femora, upper half, medullary cavity	7.3	23.1	4.0	52.8	0.1	0.2	4.0	0.3	0.0	0.1	8.1	0.0	1.030
23	Humeri and femora, lower half, medullary cavity	7.9	25.3	3.9	52.5	0.1	0.2	3.2	0.2	0.0	0.1	6.5	0.1	1.030
24	Ulnae and radii, medullary cavity	10.4	34.0	3.5	51.2	0.1	0.1	0.2	0.2	0.1	0.1	0.0	0.1	1.030
25	Tibiae, fibulae, and patellae, medullary cavity	7.3	23.1	4.0	52.8	0.1	0.2	4.0	0.3	0.0	0.1	8.1	0.0	1.030
26	Cartilage	9.6	9.9	2.2	74.4	0.5	0.0	2.2	0.9	0.3	0.0	0.0	0.0	1.100
27	Skin	10.4	10.6	2.9	75.3	0.2	0.0	0.1	0.2	0.3	0.1	0.0	0.0	1.100
28	Blood vessels	10.2	11.0	3.3	74.5	0.1	0.0	0.1	0.2	0.3	0.2	0.0	0.1	1.060
29	Oral mucosa	10.4	10.3	2.4	76.1	0.1	0.0	0.1	0.1	0.2	0.2	0.0	0.0	1.030
30	Liver	10.2	12.8	3.1	72.9	0.1	0.0	0.2	0.2	0.2	0.3	0.0	0.0	1.040
31	Pancreas	10.5	16.0	2.6	70.0	0.2	0.0	0.2	0.1	0.2	0.2	0.0	0.0	1.030
32	Brain	10.8	5.9	1.3	81.1	0.2	0.0	0.3	0.1	0.2	0.2	0.0	0.0	1.030
33	Heart wall	10.5	8.5	2.2	78.0	0.2	0.0	0.1	0.1	0.2	0.2	0.0	0.0	1.040
34	Eye lens and bulb	9.6	19.5	5.7	64.6	0.1	0.0	0.1	0.3	0.1	0.0	0.0	0.0	1.050
35	Kidney tissue	10.5	8.0	2.2	78.5	0.2	0.0	0.2	0.1	0.2	0.2	0.1	0.0	1.030
36	Stomach wall	10.4	11.9	2.7	74.2	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.0	1.030
37	Small intestine wall	10.4	12.0	2.7	74.2	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.0	1.030
38	Colon wall and rectum	10.4	12.0	2.7	74.2	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.0	1.030
39	Spleen	10.2	10.9	3.2	74.8	0.1	0.0	0.1	0.2	0.2	0.2	0.0	0.1	1.040
40	Thyroid	10.3	12.1	2.7	74.1	0.2	0.0	0.1	0.1	0.2	0.1	0.0	0.1	1.050
41	Urinary bladder wall	10.5	9.7	2.6	76.0	0.2	0.0	0.2	0.2	0.3	0.3	0.0	0.0	1.040
42	Testes	10.6	16.1	2.1	71.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	1.050
43	Adrenal glands	10.5	15.6	2.4	71.2	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	1.030
44	Oesophagus wall	10.4	15.4	2.5	71.3	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	1.030
45	Generic soft tissue (several organs)	10.5	16.0	2.2	71.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	1.030
46	Prostate	10.5	15.9	2.2	71.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	1.030
47	Lymphatic nodes	10.6	16.1	2.1	71.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	1.030
48	Breast glandular tissue	11.0	27.8	1.3	59.6	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	1.020
49	Adipose tissue	11.1	29.4	1.0	58.3	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.990
50	Lungs tissue	10.4	9.4	2.5	76.9	0.2	0.0	0.2	0.1	0.2	0.1	0.0	0.0	0.591
51	GI tract contents	10.0	22.2	2.2	64.4	0.1	0.0	0.2	0.3	0.1	0.4	0.1	0.0	1.030
52	Urine	10.7	0.3	1.0	87.3	0.4	0.0	0.1	0.0	0.0	0.2	0.0	0.0	1.010
53	Air inside the body	0.0	0.0	80.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.001

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966 Table B.2. List of media, their elemental compositions (percent by mass), and their mass densities
 967 for the *newborn female phantom*.

Medium	H ₁	C ₆	N ₇	O ₈	Na ₁₁	Mg ₁₂	P ₁₅	S ₁₆	Cl ₁₇	K ₁₉	Ca ₂₀	Fe ₂₆	I ₅₃	Density (g/cm ³)
1	Teeth	2.2	9.5	2.9	42.1	0.0	0.7	13.7	0.0	0.0	28.9	0.0	0.0	1.650
2	Mineral bone	4.5	15.8	4.5	51.4	0.0	0.3	7.5	0.3	0.0	0.0	15.6	0.0	1.650
3	Humeri, upper half, spongiosa	7.3	23.1	4.0	52.8	0.1	0.2	4.0	0.3	0.0	0.1	8.1	0.0	1.307
4	Humeri, lower half, spongiosa	10.4	34.0	3.5	51.2	0.1	0.1	0.2	0.2	0.1	0.1	0.0	0.1	1.307
5	Ulnae and radii, spongiosa	10.4	34.0	3.5	51.2	0.1	0.1	0.2	0.2	0.1	0.1	0.0	0.1	1.307
6	Wrists and hand bones, spongiosa	10.4	34.0	3.5	51.2	0.1	0.1	0.2	0.2	0.1	0.1	0.0	0.1	1.244
7	Clavicles, spongiosa	6.9	21.8	4.1	53.0	0.1	0.2	4.5	0.3	0.0	0.1	9.1	0.0	1.257
8	Cranium, spongiosa	6.3	19.4	4.2	53.4	0.0	0.2	5.3	0.3	0.0	0.0	10.8	0.0	1.433
9	Femora upper half, spongiosa	7.3	23.1	4.0	52.8	0.1	0.2	4.0	0.3	0.0	0.1	8.1	0.0	1.307
10	Femora lower half, spongiosa	7.3	23.1	4.0	52.8	0.1	0.2	4.0	0.3	0.0	0.1	8.1	0.0	1.307
11	Tibiae, fibulae, and patellae, spongiosa	7.6	24.0	4.0	52.7	0.1	0.2	3.7	0.3	0.0	0.1	7.4	0.0	1.306
12	Ankles and foot bones, spongiosa	7.3	23.1	4.0	52.8	0.1	0.2	4.0	0.3	0.0	0.1	8.1	0.0	1.244
13	Mandible, spongiosa	7.9	25.3	3.9	52.5	0.1	0.2	3.2	0.2	0.0	0.1	6.5	0.1	1.244
14	Pelvis, spongiosa	7.3	23.1	4.0	52.8	0.1	0.2	4.0	0.3	0.0	0.1	8.1	0.0	1.257
15	Ribs, spongiosa	7.9	25.2	3.9	52.5	0.1	0.2	3.3	0.3	0.0	0.1	6.5	0.0	1.244
16	Scapulae, spongiosa	7.1	22.2	4.1	52.9	0.1	0.2	4.3	0.3	0.0	0.1	8.8	0.0	1.257
17	Cervical spine, spongiosa	7.9	25.3	3.9	52.5	0.1	0.2	3.2	0.2	0.0	0.1	6.5	0.1	1.338
18	Thoracic spine, spongiosa	7.8	24.8	3.9	52.5	0.1	0.2	3.4	0.3	0.0	0.1	6.8	0.0	1.351
19	Lumbar spine, spongiosa	7.8	24.8	3.9	52.5	0.1	0.2	3.4	0.3	0.0	0.1	6.8	0.0	1.307
20	Scapulae, spongiosa	7.8	24.8	3.9	52.5	0.1	0.2	3.4	0.3	0.0	0.1	6.8	0.0	1.307
21	Sternum, spongiosa	7.3	23.1	4.0	52.8	0.1	0.2	4.0	0.3	0.0	0.1	8.1	0.0	1.245
22	Humeri and femora, upper half, medullary cavity	7.3	23.1	4.0	52.8	0.1	0.2	4.0	0.3	0.0	0.1	8.1	0.0	1.030
23	Humeri and femora, lower half, medullary cavity	7.9	25.3	3.9	52.5	0.1	0.2	3.2	0.2	0.0	0.1	6.5	0.1	1.030
24	Ulnae and radii, medullary cavity	10.4	34.0	3.5	51.2	0.1	0.1	0.2	0.2	0.1	0.1	0.0	0.1	1.030
25	Tibiae, fibulae, and patellae, medullary cavity	7.3	23.1	4.0	52.8	0.1	0.2	4.0	0.3	0.0	0.1	8.1	0.0	1.030
26	Cartilage	9.6	9.9	2.2	74.4	0.5	0.0	2.2	0.9	0.3	0.0	0.0	0.0	1.100
27	Skin	10.4	10.6	2.9	75.3	0.2	0.0	0.1	0.2	0.3	0.1	0.0	0.0	1.100
28	Blood vessels	10.2	11.0	3.3	74.5	0.1	0.0	0.1	0.2	0.3	0.2	0.0	0.1	1.060
29	Oral mucosa	10.4	10.3	2.4	76.1	0.1	0.0	0.1	0.1	0.2	0.2	0.0	0.0	1.030
30	Liver	10.2	12.8	3.1	72.9	0.1	0.0	0.2	0.2	0.2	0.3	0.0	0.0	1.040
31	Pancreas	10.5	16.0	2.6	70.0	0.2	0.0	0.2	0.1	0.2	0.2	0.0	0.0	1.030
32	Brain	10.8	5.9	1.3	81.1	0.2	0.0	0.3	0.1	0.2	0.2	0.0	0.0	1.030
33	Heart wall	10.5	8.5	2.2	78.0	0.2	0.0	0.1	0.1	0.2	0.2	0.0	0.0	1.040
34	Eye lens and bulb	9.6	19.5	5.7	64.6	0.1	0.0	0.1	0.3	0.1	0.0	0.0	0.0	1.050
35	Kidney tissue	10.5	8.0	2.2	78.5	0.2	0.0	0.2	0.1	0.2	0.2	0.1	0.0	1.030
36	Stomach wall	10.4	11.9	2.7	74.2	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.0	1.030
37	Small intestine wall	10.4	12.0	2.7	74.2	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.0	1.030
38	Colon wall and rectum	10.4	12.0	2.7	74.2	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.0	1.030
39	Spleen	10.2	10.9	3.2	74.8	0.1	0.0	0.1	0.2	0.2	0.2	0.0	0.1	1.040
40	Thyroid	10.3	12.1	2.7	74.1	0.2	0.0	0.1	0.1	0.2	0.1	0.0	0.0	1.050
41	Urinary bladder wall	10.5	9.7	2.6	76.0	0.2	0.0	0.2	0.2	0.3	0.3	0.0	0.0	1.040
42	Ovaries	10.6	16.0	2.2	71.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	1.050
43	Adrenal glands	10.5	15.6	2.4	71.2	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	1.030
44	Oesophagus wall	10.4	15.4	2.5	71.3	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	1.030
45	Generic soft tissue (several organs)	10.5	16.0	2.2	71.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	1.030
46	Uterus & cervix	10.5	16.0	2.2	71.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	1.030
47	Lymphatic nodes	10.6	16.1	2.1	71.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	1.030
48	Breast glandular tissue	11.0	28.1	1.2	59.3	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	1.020
49	Adipose tissue	11.1	29.4	1.0	58.3	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.990
50	Lungs tissue	10.4	9.4	2.5	76.9	0.2	0.0	0.2	0.1	0.2	0.1	0.0	0.0	0.591
51	GI tract contents	10.0	22.2	2.2	64.4	0.1	0.0	0.2	0.3	0.1	0.4	0.1	0.0	1.030
52	Urine	10.7	0.3	1.0	87.3	0.4	0.0	0.1	0.0	0.0	0.2	0.0	0.0	1.010
53	Air inside the body	0.0	0.0	80.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.001

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970 Table B.3. List of media, their elemental compositions (percent by mass), and their mass densities
 971 for the *1-year-old male phantom*.

Medium	H ₁	C ₆	N ₇	O ₈	Na ₁₁	Mg ₁₂	P ₁₅	S ₁₆	Cl ₁₇	K ₁₉	Ca ₂₀	Fe ₂₆	I ₅₃	Density (g/cm ³)
1 Teeth	2.2	9.5	2.9	42.1	0.0	0.7	13.7	0.0	0.0	28.9	0.0	0.0	0.0	1.650
2 Mineral bone	4.3	15.8	4.5	50.2	0.0	0.3	8.2	0.3	0.0	0.0	16.4	0.0	0.0	1.660
3 Humeri, upper half, spongiosa	6.7	22.6	4.0	50.9	0.0	0.2	5.1	0.3	0.0	0.0	10.1	0.0	0.0	1.364
4 Humeri, lower half, spongiosa	10.5	37.1	3.2	48.3	0.1	0.1	0.2	0.2	0.1	0.0	0.0	0.1	0.0	1.364
5 Ulnae and radii, spongiosa	10.5	37.4	3.2	48.1	0.1	0.1	0.2	0.2	0.1	0.0	0.0	0.1	0.0	1.414
6 Wrists and hand bones, spongiosa	10.5	37.9	3.2	47.6	0.1	0.1	0.2	0.2	0.1	0.0	0.0	0.1	0.0	1.281
7 Clavicles, spongiosa	8.7	29.8	3.6	49.9	0.1	0.2	2.5	0.2	0.0	0.0	4.8	0.1	0.0	1.295
8 Cranium, spongiosa	6.1	20.2	4.1	51.6	0.0	0.2	5.8	0.3	0.0	0.0	11.5	0.0	0.0	1.435
9 Femora upper half, spongiosa	6.7	22.4	4.0	51.3	0.0	0.2	5.0	0.3	0.0	0.0	9.9	0.0	0.0	1.344
10 Femora lower half, spongiosa	6.5	21.9	4.0	51.1	0.0	0.2	5.4	0.3	0.0	0.0	10.6	0.0	0.0	1.306
11 Tibiae, fibulae, and patellae, spongiosa	6.5	22.0	4.0	50.7	0.0	0.2	5.4	0.3	0.0	0.0	10.7	0.0	0.0	1.341
12 Ankles and foot bones, spongiosa	7.1	24.2	3.9	50.6	0.1	0.2	4.6	0.3	0.0	0.0	9.0	0.0	0.0	1.273
13 Mandible, spongiosa	6.3	20.8	4.1	51.5	0.0	0.2	5.6	0.3	0.0	0.0	11.0	0.0	0.0	1.415
14 Pelvis, spongiosa	7.5	25.5	3.8	50.7	0.1	0.2	4.0	0.3	0.0	0.0	7.8	0.0	0.0	1.214
15 Ribs, spongiosa	7.8	26.5	3.8	50.5	0.1	0.2	3.7	0.2	0.0	0.0	7.1	0.0	0.0	1.251
16 Scapulae, spongiosa	8.2	28.1	3.7	50.2	0.1	0.2	3.1	0.2	0.0	0.0	6.0	0.1	0.0	1.287
17 Cervical spine, spongiosa	7.8	26.5	3.8	50.5	0.1	0.2	3.7	0.2	0.0	0.0	7.1	0.0	0.0	1.210
18 Thoracic spine, spongiosa	7.4	25.1	3.9	50.7	0.1	0.2	4.1	0.3	0.0	0.0	8.1	0.0	0.0	1.169
19 Lumbar spine, spongiosa	7.4	24.8	3.9	50.8	0.1	0.2	4.2	0.3	0.0	0.0	8.3	0.0	0.0	1.274
20 Scapulae, spongiosa	8.2	27.9	3.7	50.2	0.1	0.2	3.2	0.2	0.0	0.0	6.1	0.1	0.0	1.276
21 Sternum, spongiosa	7.6	25.6	3.8	50.6	0.1	0.2	4.0	0.2	0.0	0.0	7.7	0.0	0.0	1.249
22 Humeri and femora, upper half, medullary cavity	6.7	22.8	4.0	50.9	0.0	0.2	5.1	0.3	0.0	0.0	10.0	0.0	0.0	1.027
23 Humeri and femora, lower half, medullary cavity	7.5	28.9	3.4	47.1	0.1	0.2	4.2	0.2	0.0	0.0	8.2	0.0	0.0	1.026
24 Ulnae and radii, medullary cavity	10.5	37.7	3.2	47.8	0.1	0.1	0.2	0.2	0.1	0.0	0.0	0.1	0.0	1.025
25 Tibiae, fibulae, and patellae, medullary cavity	7.3	25.2	3.8	50.3	0.1	0.2	4.3	0.3	0.0	0.0	8.4	0.0	0.0	1.025
26 Cartilage	9.6	10.0	2.3	74.4	0.5	0.0	2.1	0.9	0.3	0.0	0.0	0.0	0.0	1.100
27 Skin	10.0	20.0	4.2	64.9	0.2	0.0	0.1	0.2	0.3	0.1	0.0	0.0	0.0	1.100
28 Blood vessels	10.2	11.0	3.3	74.5	0.1	0.0	0.1	0.2	0.3	0.2	0.0	0.1	0.0	1.060
29 Oral mucosa	10.2	14.3	3.4	71.0	0.1	0.0	0.2	0.3	0.1	0.4	0.0	0.0	0.0	1.030
30 Liver	10.3	16.9	2.9	68.8	0.2	0.0	0.2	0.3	0.2	0.3	0.0	0.0	0.0	1.050
31 Pancreas	10.5	15.9	2.4	70.2	0.2	0.0	0.2	0.1	0.2	0.2	0.0	0.0	0.0	1.030
32 Brain	10.7	14.4	2.2	71.3	0.2	0.0	0.4	0.2	0.3	0.3	0.0	0.0	0.0	1.030
33 Heart wall	10.4	13.5	2.9	72.1	0.1	0.0	0.2	0.2	0.2	0.3	0.0	0.0	0.0	1.040
34 Eye lens and bulb	9.6	19.5	5.7	64.6	0.1	0.0	0.1	0.3	0.1	0.0	0.0	0.0	0.0	1.050
35 Kidney tissue	10.3	12.8	3.0	72.7	0.2	0.0	0.2	0.2	0.2	0.2	0.1	0.0	0.0	1.040
36 Stomach wall	10.5	11.4	2.4	75.0	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.0	0.0	1.030
37 Small intestine wall	10.5	11.4	2.4	75.0	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.0	0.0	1.030
38 Colon wall and rectum	10.5	11.4	2.4	75.0	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.0	0.0	1.030
39 Spleen	10.3	11.2	3.2	74.2	0.1	0.0	0.2	0.2	0.2	0.3	0.0	0.0	0.0	1.060
40 Thyroid	10.4	11.8	2.5	74.5	0.2	0.0	0.1	0.1	0.2	0.1	0.0	0.0	0.1	1.050
41 Urinary bladder wall	10.5	9.6	2.6	76.1	0.2	0.0	0.2	0.2	0.3	0.3	0.0	0.0	0.0	1.040
42 Testes	10.6	10.0	2.1	76.5	0.2	0.0	0.1	0.2	0.2	0.2	0.0	0.0	0.0	1.050
43 Adrenal glands	10.5	23.3	2.8	62.5	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	0.0	1.030
44 Oesophagus wall	10.4	22.7	2.8	63.0	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	0.0	1.030
45 Generic soft tissue (several organs)	10.5	24.6	2.7	61.2	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	0.0	1.030
46 Prostate	10.5	24.5	2.7	61.3	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	0.0	1.030
47 Lymphatic nodes	10.5	25.1	2.7	60.7	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	0.0	1.030
48 Breast glandular tissue	11.3	56.2	0.9	31.3	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	1.020
49 Adipose tissue	11.4	59.1	0.7	28.4	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.960
50 Lungs tissue	10.3	10.7	3.2	74.8	0.2	0.0	0.2	0.3	0.3	0.2	0.0	0.0	0.0	0.393
51 GI tract contents	10.0	22.2	2.2	64.4	0.1	0.0	0.2	0.3	0.1	0.4	0.1	0.0	0.0	1.030
52 Urine	10.7	0.3	1.0	87.3	0.4	0.0	0.1	0.0	0.0	0.2	0.0	0.0	0.0	1.010
53 Air inside the body	0.0	0.0	75.5	23.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.001

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974 Table B.4. List of media, their elemental compositions (percent by mass), and their mass
 975 densities for the *1-year-old female phantom*.

Medium	H ₁	C ₆	N ₇	O ₈	Na ₁₁	Mg ₁₂	P ₁₅	S ₁₆	Cl ₁₇	K ₁₉	Ca ₂₀	Fe ₂₆	I ₅₃	Density (g/cm ³)
1	Teeth	2.2	9.5	2.9	42.1	0.0	0.7	13.7	0.0	0.0	28.9	0.0	0.0	1.650
2	Mineral bone	4.3	15.8	4.5	50.2	0.0	0.3	8.2	0.3	0.0	16.4	0.0	0.0	1.660
3	Humeri, upper half, spongiosa	6.7	22.6	4.0	50.9	0.0	0.2	5.1	0.3	0.0	10.1	0.0	0.0	1.364
4	Humeri, lower half, spongiosa	10.5	37.1	3.2	48.3	0.1	0.1	0.2	0.2	0.1	0.0	0.1	0.0	1.364
5	Ulnae and radii, spongiosa	10.5	37.4	3.2	48.1	0.1	0.1	0.2	0.2	0.1	0.0	0.0	0.1	1.414
6	Wrists and hand bones, spongiosa	10.5	37.9	3.2	47.6	0.1	0.1	0.2	0.2	0.1	0.0	0.0	0.1	1.281
7	Clavicles, spongiosa	8.7	29.8	3.6	49.9	0.1	0.2	2.5	0.2	0.0	0.0	4.8	0.1	1.295
8	Cranium, spongiosa	6.1	20.2	4.1	51.6	0.0	0.2	5.8	0.3	0.0	0.0	11.5	0.0	1.435
9	Femora upper half, spongiosa	6.7	22.4	4.0	51.3	0.0	0.2	5.0	0.3	0.0	0.0	9.9	0.0	1.344
10	Femora lower half, spongiosa	6.5	21.9	4.0	51.1	0.0	0.2	5.4	0.3	0.0	0.0	10.6	0.0	1.306
11	Tibiae, fibulae, and patellae, spongiosa	6.5	22.0	4.0	50.7	0.0	0.2	5.4	0.3	0.0	0.0	10.7	0.0	1.341
12	Ankles and foot bones, spongiosa	7.1	24.2	3.9	50.6	0.1	0.2	4.6	0.3	0.0	0.0	9.0	0.0	1.273
13	Mandible, spongiosa	6.3	20.8	4.1	51.5	0.0	0.2	5.6	0.3	0.0	0.0	11.0	0.0	1.415
14	Pelvis, spongiosa	7.5	25.5	3.8	50.7	0.1	0.2	4.0	0.3	0.0	0.0	7.8	0.0	1.214
15	Ribs, spongiosa	7.8	26.5	3.8	50.5	0.1	0.2	3.7	0.2	0.0	0.0	7.1	0.0	1.251
16	Scapulae, spongiosa	8.2	28.1	3.7	50.2	0.1	0.2	3.1	0.2	0.0	0.0	6.0	0.1	1.287
17	Cervical spine, spongiosa	7.8	26.5	3.8	50.5	0.1	0.2	3.7	0.2	0.0	0.0	7.1	0.0	1.210
18	Thoracic spine, spongiosa	7.4	25.1	3.9	50.7	0.1	0.2	4.1	0.3	0.0	0.0	8.1	0.0	1.169
19	Lumbar spine, spongiosa	7.4	24.8	3.9	50.8	0.1	0.2	4.2	0.3	0.0	0.0	8.3	0.0	1.274
20	Scarum, spongiosa	8.2	27.9	3.7	50.2	0.1	0.2	3.2	0.2	0.0	0.0	6.1	0.1	1.276
21	Sternum, spongiosa	7.6	25.6	3.8	50.6	0.1	0.2	4.0	0.2	0.0	0.0	7.7	0.0	1.249
22	Humeri and femora, upper half, medullary cavity	6.7	22.8	4.0	50.9	0.0	0.2	5.1	0.3	0.0	0.0	10.0	0.0	1.027
23	Humeri and femora, lower half, medullary cavity	7.5	28.9	3.4	47.1	0.1	0.2	4.2	0.2	0.0	0.0	8.2	0.0	1.026
24	Ulnae and radii, medullary cavity	10.5	37.7	3.2	47.8	0.1	0.1	0.2	0.2	0.1	0.0	0.1	0.0	1.025
25	Tibiae, fibulae, and patellae, medullary cavity	7.3	25.2	3.8	50.3	0.1	0.2	4.3	0.3	0.0	0.0	8.4	0.0	1.025
26	Cartilage	9.6	10.0	2.3	74.4	0.5	0.0	2.1	0.9	0.3	0.0	0.0	0.0	1.100
27	Skin	10.0	20.0	4.2	64.9	0.2	0.0	0.1	0.2	0.3	0.1	0.0	0.0	1.100
28	Blood vessels	10.2	11.0	3.3	74.5	0.1	0.0	0.1	0.2	0.3	0.2	0.0	0.1	1.060
29	Oral mucosa	10.2	14.3	3.4	71.0	0.1	0.0	0.2	0.3	0.1	0.4	0.0	0.0	1.030
30	Liver	10.3	16.9	2.9	68.8	0.2	0.0	0.2	0.3	0.2	0.3	0.0	0.0	1.050
31	Pancreas	10.5	15.9	2.4	70.2	0.2	0.0	0.2	0.1	0.2	0.2	0.0	0.0	1.030
32	Brain	10.7	14.4	2.2	71.3	0.2	0.0	0.4	0.2	0.3	0.3	0.0	0.0	1.030
33	Heart wall	10.4	13.5	2.9	72.1	0.1	0.0	0.2	0.2	0.2	0.3	0.0	0.0	1.040
34	Eye lens and bulb	9.6	19.5	5.7	64.6	0.1	0.0	0.1	0.3	0.1	0.0	0.0	0.0	1.050
35	Kidney tissue	10.3	12.8	3.0	72.7	0.2	0.0	0.2	0.2	0.2	0.1	0.0	0.0	1.040
36	Stomach wall	10.5	11.4	2.4	75.0	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.0	1.030
37	Small intestine wall	10.5	11.4	2.4	75.0	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.0	1.030
38	Colon wall and rectum	10.5	11.4	2.4	75.0	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.0	1.030
39	Spleen	10.3	11.2	3.2	74.2	0.1	0.0	0.2	0.2	0.2	0.3	0.0	0.0	1.060
40	Thyroid	10.4	11.8	2.5	74.5	0.2	0.0	0.1	0.1	0.2	0.1	0.0	0.1	1.050
41	Urinary bladder wall	10.5	9.6	2.6	76.1	0.2	0.0	0.2	0.2	0.3	0.3	0.0	0.0	1.040
42	Ovaries	10.5	24.8	2.7	61.0	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	1.050
43	Adrenal glands	10.5	23.3	2.8	62.5	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	1.030
44	Oesophagus wall	10.4	22.7	2.8	63.0	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	1.030
45	Generic soft tissue (several organs)	10.5	24.6	2.7	61.2	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	1.030
46	Uterus & cervix	10.6	30.1	2.5	56.0	0.1	0.0	0.2	0.2	0.1	0.2	0.0	0.0	1.030
47	Lymphatic nodes	10.5	25.1	2.7	60.7	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	1.030
48	Breast glandular tissue	11.5	49.2	0.2	39.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.020
49	Adipose tissue	11.4	59.1	0.7	28.4	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.960
50	Lungs tissue	10.3	10.7	3.2	74.8	0.2	0.0	0.2	0.3	0.3	0.2	0.0	0.0	0.393
51	GI tract contents	10.0	22.2	2.2	64.4	0.1	0.0	0.2	0.3	0.1	0.4	0.1	0.0	1.030
52	Urine	10.7	0.3	1.0	87.3	0.4	0.0	0.1	0.0	0.0	0.2	0.0	0.0	1.010
53	Air inside the body	0.0	0.0	75.5	23.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.001

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978 Table B.5. List of media, their elemental compositions (percent by mass), and their mass densities
 979 for the *5-year-old male phantom*.

Medium	H ₁	C ₆	N ₇	O ₈	Na ₁₁	Mg ₁₂	P ₁₅	S ₁₆	Cl ₁₇	K ₁₉	Ca ₂₀	Fe ₂₆	I ₅₃	Density (g/cm ³)
1	Teeth	2.2	9.5	2.9	42.1	0.0	0.7	13.7	0.0	0.0	28.9	0.0	0.0	1.650
2	Mineral bone	4.2	15.8	4.5	47.9	0.1	0.2	8.7	0.3	0.0	18.3	0.0	0.0	1.700
3	Humeri, upper half, spongiosa	8.6	33.9	3.1	44.7	0.1	0.1	3.0	0.2	0.0	6.1	0.0	0.0	1.295
4	Humeri, lower half, spongiosa	10.7	41.2	2.8	44.6	0.1	0.1	0.2	0.2	0.0	0.0	0.1	0.0	1.281
5	Ulnae and radii, spongiosa	10.7	42.6	2.7	43.3	0.1	0.1	0.2	0.2	0.0	0.0	0.1	0.0	1.261
6	Wrists and hand bones, spongiosa	10.8	45.1	2.4	41.0	0.1	0.1	0.2	0.2	0.0	0.0	0.1	0.0	1.229
7	Clavicles, spongiosa	8.7	30.9	3.5	48.3	0.1	0.1	2.7	0.2	0.1	0.0	5.3	0.1	1.233
8	Cranium, spongiosa	6.9	23.7	3.9	49.3	0.1	0.2	5.1	0.3	0.0	10.6	0.0	0.0	1.374
9	Femora upper half, spongiosa	7.5	26.6	3.7	48.6	0.1	0.2	4.2	0.2	0.0	8.7	0.0	0.0	1.294
10	Femora lower half, spongiosa	7.9	30.3	3.4	45.9	0.1	0.1	3.9	0.2	0.0	8.0	0.0	0.0	1.256
11	Tibiae, fibulae, and patellae, spongiosa	7.7	30.0	3.4	45.7	0.1	0.1	4.1	0.2	0.0	8.5	0.0	0.0	1.213
12	Ankles and foot bones, spongiosa	8.9	35.4	3.1	44.1	0.1	0.1	2.7	0.2	0.0	5.4	0.0	0.0	1.243
13	Mandible, spongiosa	7.2	25.0	3.8	49.0	0.1	0.2	4.7	0.3	0.0	9.8	0.0	0.0	1.338
14	Pelvis, spongiosa	8.9	32.4	3.4	47.4	0.1	0.1	2.5	0.2	0.0	5.0	0.1	0.0	1.190
15	Ribs, spongiosa	8.8	31.5	3.5	48.2	0.1	0.1	2.5	0.2	0.1	4.9	0.1	0.0	1.236
16	Scapulae, spongiosa	8.1	28.5	3.6	48.7	0.1	0.2	3.4	0.2	0.1	7.0	0.1	0.0	1.258
17	Cervical spine, spongiosa	8.1	28.4	3.6	48.7	0.1	0.2	3.5	0.2	0.1	7.1	0.1	0.0	1.234
18	Thoracic spine, spongiosa	7.9	28.0	3.6	48.4	0.1	0.1	3.8	0.2	0.0	7.8	0.0	0.0	1.175
19	Lumbar spine, spongiosa	8.1	29.1	3.6	48.1	0.1	0.1	3.5	0.2	0.0	7.1	0.0	0.0	1.233
20	Scarum, spongiosa	8.5	31.0	3.4	47.7	0.1	0.1	2.9	0.2	0.0	5.9	0.1	0.0	1.160
21	Sternum, spongiosa	8.1	28.5	3.6	48.7	0.1	0.2	3.4	0.2	0.1	7.0	0.1	0.0	1.163
22	Humeri and femora, upper half, medullary cavity	8.6	34.1	3.1	44.7	0.1	0.1	3.0	0.2	0.0	6.0	0.0	0.0	1.018
23	Humeri and femora, lower half, medullary cavity	8.0	34.1	3.0	42.2	0.1	0.1	4.0	0.2	0.0	8.3	0.0	0.0	1.017
24	Ulnae and radii, medullary cavity	10.7	43.3	2.6	42.6	0.1	0.1	0.2	0.2	0.0	0.0	0.1	0.0	1.008
25	Tibiae, fibulae, and patellae, medullary cavity	9.1	36.7	3.0	43.8	0.1	0.1	2.3	0.2	0.0	4.6	0.0	0.0	1.009
26	Cartilage	9.6	10.0	2.3	74.4	0.5	0.0	2.1	0.9	0.3	0.0	0.0	0.0	1.100
27	Skin	10.0	20.0	4.2	65.0	0.2	0.0	0.1	0.2	0.3	0.1	0.0	0.0	1.100
28	Blood vessels	10.2	11.0	3.3	74.5	0.1	0.0	0.1	0.2	0.3	0.2	0.0	0.1	1.060
29	Oral mucosa	10.2	14.2	3.4	71.1	0.1	0.0	0.2	0.3	0.1	0.4	0.0	0.0	1.030
30	Liver	10.3	16.4	2.9	69.3	0.2	0.0	0.2	0.3	0.2	0.3	0.0	0.0	1.050
31	Pancreas	10.5	15.6	2.4	70.5	0.2	0.0	0.2	0.1	0.2	0.2	0.0	0.0	1.030
32	Brain	10.7	14.3	2.3	71.4	0.2	0.0	0.4	0.2	0.3	0.3	0.0	0.0	1.040
33	Heart wall	10.4	13.4	3.0	72.2	0.1	0.0	0.2	0.2	0.2	0.3	0.0	0.0	1.040
34	Eye lens and bulb	9.6	19.5	5.7	64.6	0.1	0.0	0.1	0.3	0.1	0.0	0.0	0.0	1.050
35	Kidney tissue	10.3	12.5	3.1	73.1	0.2	0.0	0.2	0.2	0.2	0.1	0.0	0.1	1.040
36	Stomach wall	10.5	11.4	2.5	74.9	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.0	1.030
37	Small intestine wall	10.5	11.4	2.5	74.9	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.0	1.030
38	Colon wall and rectum	10.5	11.4	2.5	74.9	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.0	1.030
39	Spleen	10.3	11.2	3.2	74.3	0.1	0.0	0.2	0.2	0.2	0.3	0.0	0.0	1.060
40	Thyroid	10.4	11.8	2.5	74.5	0.2	0.0	0.1	0.1	0.2	0.1	0.0	0.1	1.050
41	Urinary bladder wall	10.5	9.6	2.6	76.1	0.2	0.0	0.2	0.2	0.3	0.3	0.0	0.0	1.040
42	Testes	10.6	10.0	2.1	76.5	0.2	0.0	0.1	0.2	0.2	0.2	0.0	0.0	1.050
43	Adrenal glands	10.4	22.6	2.8	63.1	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	1.030
44	Oesophagus wall	10.4	21.9	2.9	63.8	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	1.030
45	Generic soft tissue (several organs)	10.5	23.6	2.8	62.2	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	1.030
46	Prostate	10.5	23.6	2.8	62.1	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	1.030
47	Lymphatic nodes	10.5	24.9	2.7	60.9	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	1.030
48	Breast glandular tissue	11.2	53.2	1.1	34.1	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	1.020
49	Adipose tissue	11.4	58.9	0.7	28.6	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.960
50	Lungs tissue	10.3	10.7	3.2	74.7	0.2	0.0	0.2	0.3	0.3	0.2	0.0	0.0	0.386
51	GI tract contents	10.0	22.2	2.2	64.4	0.1	0.0	0.2	0.3	0.1	0.4	0.1	0.0	1.030
52	Urine	10.7	0.3	1.0	87.3	0.4	0.0	0.1	0.0	0.0	0.2	0.0	0.0	1.010
53	Air inside the body	0.0	0.0	75.5	23.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.001

982 Table B.6. List of media, their elemental compositions (percent by mass), and their mass densities
 983 for the *5-year-old female phantom*.

Medium	H ₁	C ₆	N ₇	O ₈	Na ₁₁	Mg ₁₂	P ₁₅	S ₁₆	Cl ₁₇	K ₁₉	Ca ₂₀	Fe ₂₆	I ₅₃	Density (g/cm ³)
1	Teeth	2.2	9.5	2.9	42.1	0.0	0.7	13.7	0.0	0.0	28.9	0.0	0.0	1.650
2	Mineral bone	4.2	15.8	4.5	47.9	0.1	0.2	8.7	0.3	0.0	0.0	18.3	0.0	1.700
3	Humeri, upper half, spongiosa	8.6	33.9	3.1	44.7	0.1	0.1	3.0	0.2	0.0	0.0	6.1	0.0	1.295
4	Humeri, lower half, spongiosa	10.7	41.2	2.8	44.6	0.1	0.1	0.2	0.2	0.0	0.0	0.1	0.0	1.281
5	Ulnae and radii, spongiosa	10.7	42.6	2.7	43.3	0.1	0.1	0.2	0.2	0.0	0.0	0.0	0.1	1.261
6	Wrists and hand bones, spongiosa	10.8	45.1	2.4	41.0	0.1	0.1	0.2	0.2	0.0	0.0	0.1	0.0	1.229
7	Clavicles, spongiosa	8.7	30.9	3.5	48.3	0.1	0.1	2.7	0.2	0.1	0.0	5.3	0.1	1.233
8	Cranium, spongiosa	6.9	23.7	3.9	49.3	0.1	0.2	5.1	0.3	0.0	0.0	10.6	0.0	1.374
9	Femora upper half, spongiosa	7.5	26.6	3.7	48.6	0.1	0.2	4.2	0.2	0.0	0.0	8.7	0.0	1.294
10	Femora lower half, spongiosa	7.9	30.3	3.4	45.9	0.1	0.1	3.9	0.2	0.0	0.0	8.0	0.0	1.256
11	Tibiae, fibulae, and patellae, spongiosa	7.7	30.0	3.4	45.7	0.1	0.1	4.1	0.2	0.0	0.0	8.5	0.0	1.213
12	Ankles and foot bones, spongiosa	8.9	35.4	3.1	44.1	0.1	0.1	2.7	0.2	0.0	0.0	5.4	0.0	1.243
13	Mandible, spongiosa	7.2	25.0	3.8	49.0	0.1	0.2	4.7	0.3	0.0	0.0	9.8	0.0	1.338
14	Pelvis, spongiosa	8.9	32.4	3.4	47.4	0.1	0.1	2.5	0.2	0.0	0.0	5.0	0.1	1.190
15	Ribs, spongiosa	8.8	31.5	3.5	48.2	0.1	0.1	2.5	0.2	0.1	0.0	4.9	0.1	1.236
16	Scapulae, spongiosa	8.1	28.5	3.6	48.7	0.1	0.2	3.4	0.2	0.1	0.0	7.0	0.1	1.258
17	Cervical spine, spongiosa	8.1	28.4	3.6	48.7	0.1	0.2	3.5	0.2	0.1	0.0	7.1	0.1	1.234
18	Thoracic spine, spongiosa	7.9	28.0	3.6	48.4	0.1	0.1	3.8	0.2	0.0	0.0	7.8	0.0	1.175
19	Lumbar spine, spongiosa	8.1	29.1	3.6	48.1	0.1	0.1	3.5	0.2	0.0	0.0	7.1	0.0	1.233
20	Scarium, spongiosa	8.5	31.0	3.4	47.7	0.1	0.1	2.9	0.2	0.0	0.0	5.9	0.1	1.160
21	Sternum, spongiosa	8.1	28.5	3.6	48.7	0.1	0.2	3.4	0.2	0.1	0.0	7.0	0.1	1.163
22	Humeri and femora, upper half, medullary cavity	8.6	34.1	3.1	44.7	0.1	0.1	3.0	0.2	0.0	0.0	6.0	0.0	1.018
23	Humeri and femora, lower half, medullary cavity	8.0	34.1	3.0	42.2	0.1	0.1	4.0	0.2	0.0	0.0	8.3	0.0	1.017
24	Ulnae and radii, medullary cavity	10.7	43.3	2.6	42.6	0.1	0.1	0.2	0.2	0.0	0.0	0.1	0.0	1.008
25	Tibiae, fibulae, and patellae, medullary cavity	9.1	36.7	3.0	43.8	0.1	0.1	2.3	0.2	0.0	0.0	4.6	0.0	1.009
26	Cartilage	9.6	10.0	2.3	74.4	0.5	0.0	2.1	0.9	0.3	0.0	0.0	0.0	1.100
27	Skin	10.0	20.0	4.2	65.0	0.2	0.0	0.1	0.2	0.3	0.1	0.0	0.0	1.100
28	Blood vessels	10.2	11.0	3.3	74.5	0.1	0.0	0.1	0.2	0.3	0.2	0.0	0.1	1.060
29	Oral mucosa	10.2	14.2	3.4	71.1	0.1	0.0	0.2	0.3	0.1	0.4	0.0	0.0	1.030
30	Liver	10.3	16.4	2.9	69.3	0.2	0.0	0.2	0.3	0.2	0.3	0.0	0.0	1.050
31	Pancreas	10.5	15.6	2.4	70.5	0.2	0.0	0.2	0.1	0.2	0.2	0.0	0.0	1.030
32	Brain	10.7	14.3	2.3	71.4	0.2	0.0	0.4	0.2	0.3	0.3	0.0	0.0	1.040
33	Heart wall	10.4	13.4	3.0	72.2	0.1	0.0	0.2	0.2	0.2	0.3	0.0	0.0	1.040
34	Eye lens and bulb	9.6	19.5	5.7	64.6	0.1	0.0	0.1	0.3	0.1	0.0	0.0	0.0	1.050
35	Kidney tissue	10.3	12.5	3.1	73.1	0.2	0.0	0.2	0.2	0.2	0.2	0.1	0.0	1.040
36	Stomach wall	10.5	11.4	2.5	74.9	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.0	1.030
37	Small intestine wall	10.5	11.4	2.5	74.9	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.0	1.030
38	Colon wall and rectum	10.5	11.4	2.5	74.9	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.0	1.030
39	Spleen	10.3	11.2	3.2	74.3	0.1	0.0	0.2	0.2	0.2	0.3	0.0	0.0	1.060
40	Thyroid	10.4	11.8	2.5	74.5	0.2	0.0	0.1	0.1	0.2	0.1	0.0	0.1	1.050
41	Urinary bladder wall	10.5	9.6	2.6	76.1	0.2	0.0	0.2	0.2	0.3	0.3	0.0	0.0	1.040
42	Ovaries	10.5	24.5	2.7	61.3	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	1.050
43	Adrenal glands	10.4	22.6	2.8	63.1	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	1.030
44	Oesophagus wall	10.4	21.9	2.9	63.8	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	1.030
45	Generic soft tissue (several organs)	10.5	23.6	2.8	62.2	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	1.030
46	Uterus & cervix	10.5	28.7	2.5	57.4	0.1	0.0	0.2	0.2	0.1	0.2	0.0	0.0	1.030
47	Lymphatic nodes	10.5	24.9	2.7	60.9	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	1.030
48	Breast glandular tissue	11.4	46.3	0.5	41.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.020
49	Adipose tissue	11.4	58.9	0.7	28.6	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.960
50	Lungs tissue	10.3	10.7	3.2	74.7	0.2	0.0	0.2	0.3	0.3	0.2	0.0	0.0	0.386
51	GI tract contents	10.0	22.2	2.2	64.4	0.1	0.0	0.2	0.3	0.1	0.4	0.1	0.0	1.030
52	Urine	10.7	0.3	1.0	87.3	0.4	0.0	0.1	0.0	0.0	0.2	0.0	0.0	1.010
53	Air inside the body	0.0	0.0	75.5	23.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.001

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986 Table B.7. List of media, their elemental compositions (percent by mass), and their mass densities
 987 for the *10-year-old male phantom*.

Medium	H ₁	C ₆	N ₇	O ₈	Na ₁₁	Mg ₁₂	P ₁₅	S ₁₆	Cl ₁₇	K ₁₉	Ca ₂₀	Fe ₂₆	I ₅₃	Density (g/cm ³)
1	Teeth	2.2	9.5	2.9	42.1	0.0	0.7	13.7	0.0	0.0	28.9	0.0	0.0	2.330
2	Mineral bone	4.1	15.9	4.4	46.3	0.1	0.2	9.3	0.3	0.0	0.0	19.5	0.0	1.750
3	Humeri, upper half, spongiosa	9.1	41.3	2.4	38.5	0.1	0.1	2.7	0.2	0.0	0.0	5.5	0.0	1.226
4	Humeri, lower half, spongiosa	10.9	47.7	2.2	38.6	0.1	0.1	0.2	0.2	0.0	0.0	0.1	0.0	1.196
5	Ulnae and radii, spongiosa	11.0	49.9	2.0	36.5	0.1	0.1	0.1	0.2	0.0	0.0	0.0	0.0	1.212
6	Wrists and hand bones, spongiosa	11.2	54.7	1.5	32.2	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	1.135
7	Clavicles, spongiosa	9.4	35.0	3.2	46.4	0.1	0.1	1.8	0.2	0.0	0.0	3.5	0.1	1.135
8	Cranium, spongiosa	7.7	28.2	3.5	47.0	0.1	0.1	4.3	0.2	0.1	0.0	8.8	0.0	1.294
9	Femora upper half, spongiosa	8.3	30.7	3.4	46.6	0.1	0.1	3.4	0.2	0.1	0.0	7.0	0.0	1.236
10	Femora lower half, spongiosa	8.5	37.3	2.7	40.5	0.1	0.1	3.5	0.2	0.0	0.0	7.1	0.0	1.210
11	Tibiae, fibulae, and patellae, spongiosa	8.5	37.3	2.7	40.4	0.1	0.1	3.5	0.2	0.0	0.0	7.2	0.0	1.148
12	Ankles and foot bones, spongiosa	9.3	42.4	2.3	38.0	0.1	0.1	2.5	0.2	0.0	0.0	5.0	0.0	1.153
13	Mandible, spongiosa	8.0	29.8	3.4	46.5	0.1	0.1	3.9	0.2	0.1	0.0	7.9	0.0	1.258
14	Pelvis, spongiosa	9.9	38.6	3.0	44.5	0.1	0.1	1.2	0.2	0.0	0.0	2.3	0.1	1.124
15	Ribs, spongiosa	9.8	36.7	3.1	46.0	0.1	0.1	1.3	0.2	0.0	0.0	2.5	0.1	1.135
16	Scapulae, spongiosa	9.0	33.2	3.3	46.9	0.1	0.1	2.3	0.2	0.1	0.0	4.7	0.1	1.177
17	Cervical spine, spongiosa	9.2	33.9	3.3	46.7	0.1	0.1	2.1	0.2	0.1	0.0	4.2	0.1	1.150
18	Thoracic spine, spongiosa	8.7	33.7	3.2	45.2	0.1	0.1	2.8	0.2	0.0	0.0	5.8	0.0	1.114
19	Lumbar spine, spongiosa	9.2	36.3	3.0	44.2	0.1	0.1	2.3	0.2	0.0	0.0	4.5	0.1	1.160
20	Scapulae, spongiosa	9.3	35.6	3.1	45.3	0.1	0.1	2.0	0.2	0.0	0.0	4.0	0.1	1.075
21	Sternum, spongiosa	8.9	32.7	3.3	47.0	0.1	0.1	2.5	0.2	0.1	0.0	5.0	0.1	1.085
22	Humeri and femora, upper half, medullary cavity	9.1	41.5	2.4	38.4	0.1	0.1	2.7	0.2	0.0	0.0	5.4	0.0	1.005
23	Humeri and femora, lower half, medullary cavity	9.0	43.5	2.1	35.7	0.1	0.1	3.0	0.2	0.0	0.0	6.2	0.0	1.004
24	Ulnae and radii, medullary cavity	11.0	51.1	1.9	35.4	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.992
25	Tibiae, fibulae, and patellae, medullary cavity	9.5	43.4	2.3	37.6	0.1	0.1	2.3	0.2	0.0	0.0	4.6	0.0	0.991
26	Cartilage	9.6	9.9	2.2	74.4	0.5	0.0	2.1	0.9	0.3	0.0	0.0	0.0	1.100
27	Skin	10.0	20.1	4.2	64.9	0.2	0.0	0.1	0.2	0.3	0.1	0.0	0.0	1.100
28	Blood vessels	10.2	11.0	3.3	74.5	0.1	0.0	0.1	0.2	0.3	0.2	0.0	0.1	1.060
29	Oral mucosa	10.2	14.2	3.4	71.1	0.1	0.0	0.2	0.3	0.1	0.4	0.0	0.0	1.030
30	Liver	10.3	16.4	2.9	69.3	0.2	0.0	0.2	0.3	0.2	0.3	0.0	0.0	1.050
31	Pancreas	10.5	15.6	2.4	70.5	0.2	0.0	0.2	0.1	0.2	0.2	0.0	0.0	1.030
32	Brain	10.7	14.3	2.3	71.4	0.2	0.0	0.4	0.2	0.3	0.3	0.0	0.0	1.040
33	Heart wall	10.4	13.4	3.0	72.2	0.1	0.0	0.2	0.2	0.2	0.3	0.0	0.0	1.040
34	Eye lens and bulb	9.6	19.5	5.7	64.6	0.1	0.0	0.1	0.3	0.1	0.0	0.0	0.0	1.050
35	Kidney tissue	10.3	12.5	3.1	73.1	0.2	0.0	0.2	0.2	0.2	0.2	0.1	0.0	1.040
36	Stomach wall	10.5	11.4	2.5	74.9	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.0	1.030
37	Small intestine wall	10.5	11.4	2.5	74.9	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.0	1.030
38	Colon wall and rectum	10.5	11.4	2.5	74.9	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.0	1.030
39	Spleen	10.3	11.2	3.2	74.3	0.1	0.0	0.2	0.2	0.2	0.3	0.0	0.0	1.060
40	Thyroid	10.4	11.8	2.5	74.5	0.2	0.0	0.1	0.1	0.2	0.1	0.0	0.1	1.050
41	Urinary bladder wall	10.5	9.6	2.6	76.1	0.2	0.0	0.2	0.2	0.3	0.3	0.0	0.0	1.040
42	Testes	10.6	10.0	2.1	76.5	0.2	0.0	0.1	0.2	0.2	0.2	0.0	0.0	1.050
43	Adrenal glands	10.4	22.6	2.8	63.1	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	1.030
44	Oesophagus wall	10.4	21.9	2.9	63.8	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	1.030
45	Generic soft tissue (several organs)	10.5	23.3	2.8	62.5	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	1.030
46	Prostate	10.5	23.2	2.8	62.5	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	1.030
47	Lymphatic nodes	10.5	24.9	2.7	60.9	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	1.030
48	Breast glandular tissue	11.2	51.9	1.1	35.4	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	1.020
49	Adipose tissue	11.4	58.9	0.7	28.6	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.960
50	Lungs tissue	10.2	10.8	3.2	74.7	0.1	0.0	0.1	0.2	0.3	0.2	0.0	0.1	0.434
51	GI tract contents	10.0	22.2	2.2	64.4	0.1	0.0	0.2	0.3	0.1	0.4	0.1	0.0	1.030
52	Urine	10.7	0.3	1.0	87.3	0.4	0.0	0.1	0.0	0.0	0.2	0.0	0.0	1.010
53	Air inside the body	0.0	0.0	75.5	23.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.001

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990 Table B.8. List of media, their elemental compositions (percent by mass), and their mass densities
 991 for the *10-year-old female phantom*.

Medium	H ₁	C ₆	N ₇	O ₈	Na ₁₁	Mg ₁₂	P ₁₅	S ₁₆	Cl ₁₇	K ₁₉	Ca ₂₀	Fe ₂₆	I ₅₃	Density (g/cm ³)
1 Teeth	2.2	9.5	2.9	42.1	0.0	0.7	13.7	0.0	0.0	28.9	0.0	0.0	0.0	2.330
2 Mineral bone	4.1	15.9	4.4	46.3	0.1	0.2	9.3	0.3	0.0	0.0	19.5	0.0	0.0	1.750
3 Humeri, upper half, spongiosa	9.1	41.3	2.4	38.5	0.1	0.1	2.7	0.2	0.0	0.0	5.5	0.0	0.0	1.226
4 Humeri, lower half, spongiosa	10.9	47.7	2.2	38.6	0.1	0.1	0.2	0.2	0.0	0.0	0.0	0.1	0.0	1.196
5 Ulnae and radii, spongiosa	11.0	49.9	2.0	36.5	0.1	0.1	0.1	0.2	0.0	0.0	0.0	0.0	0.0	1.212
6 Wrists and hand bones, spongiosa	11.2	54.7	1.5	32.2	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	1.135
7 Clavicles, spongiosa	9.4	35.0	3.2	46.4	0.1	0.1	1.8	0.2	0.0	0.0	3.5	0.1	0.0	1.135
8 Cranium, spongiosa	7.7	28.2	3.5	47.0	0.1	0.1	4.3	0.2	0.1	0.0	8.8	0.0	0.0	1.294
9 Femora upper half, spongiosa	8.3	30.7	3.4	46.6	0.1	0.1	3.4	0.2	0.1	0.0	7.0	0.0	0.0	1.236
10 Femora lower half, spongiosa	8.5	37.3	2.7	40.5	0.1	0.1	3.5	0.2	0.0	0.0	7.1	0.0	0.0	1.210
11 Tibiae, fibulae, and patellae, spongiosa	8.5	37.3	2.7	40.4	0.1	0.1	3.5	0.2	0.0	0.0	7.2	0.0	0.0	1.148
12 Ankles and foot bones, spongiosa	9.3	42.4	2.3	38.0	0.1	0.1	2.5	0.2	0.0	0.0	5.0	0.0	0.0	1.153
13 Mandible, spongiosa	8.0	29.8	3.4	46.5	0.1	0.1	3.9	0.2	0.1	0.0	7.9	0.0	0.0	1.258
14 Pelvis, spongiosa	9.9	38.6	3.0	44.5	0.1	0.1	1.2	0.2	0.0	0.0	2.3	0.1	0.0	1.124
15 Ribs, spongiosa	9.8	36.7	3.1	46.0	0.1	0.1	1.3	0.2	0.0	0.0	2.5	0.1	0.0	1.135
16 Scapulae, spongiosa	9.0	33.2	3.3	46.9	0.1	0.1	2.3	0.2	0.1	0.0	4.7	0.1	0.0	1.177
17 Cervical spine, spongiosa	9.2	33.9	3.3	46.7	0.1	0.1	2.1	0.2	0.1	0.0	4.2	0.1	0.0	1.150
18 Thoracic spine, spongiosa	8.7	33.7	3.2	45.2	0.1	0.1	2.8	0.2	0.0	0.0	5.8	0.0	0.0	1.114
19 Lumbar spine, spongiosa	9.2	36.3	3.0	44.2	0.1	0.1	2.3	0.2	0.0	0.0	4.5	0.1	0.0	1.160
20 Scapulae, spongiosa	9.3	35.6	3.1	45.3	0.1	0.1	2.0	0.2	0.0	0.0	4.0	0.1	0.0	1.075
21 Sternum, spongiosa	8.9	32.7	3.3	47.0	0.1	0.1	2.5	0.2	0.1	0.0	5.0	0.1	0.0	1.085
22 Humeri and femora, upper half, medullary cavity	9.1	41.5	2.4	38.4	0.1	0.1	2.7	0.2	0.0	0.0	5.4	0.0	0.0	1.005
23 Humeri and femora, lower half, medullary cavity	9.0	43.5	2.1	35.7	0.1	0.1	3.0	0.2	0.0	0.0	6.2	0.0	0.0	1.004
24 Ulnae and radii, medullary cavity	11.0	51.1	1.9	35.4	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.992
25 Tibiae, fibulae, and patellae, medullary cavity	9.5	43.4	2.3	37.6	0.1	0.1	2.3	0.2	0.0	0.0	4.6	0.0	0.0	0.991
26 Cartilage	9.6	9.9	2.2	74.4	0.5	0.0	2.1	0.9	0.3	0.0	0.0	0.0	0.0	1.100
27 Skin	10.0	20.1	4.2	64.9	0.2	0.0	0.1	0.2	0.3	0.1	0.0	0.0	0.0	1.100
28 Blood vessels	10.2	11.0	3.3	74.5	0.1	0.0	0.1	0.2	0.3	0.2	0.0	0.1	0.0	1.060
29 Oral mucosa	10.2	14.2	3.4	71.1	0.1	0.0	0.2	0.3	0.1	0.4	0.0	0.0	0.0	1.030
30 Liver	10.3	16.4	2.9	69.3	0.2	0.0	0.2	0.3	0.2	0.3	0.0	0.0	0.0	1.050
31 Pancreas	10.5	15.6	2.4	70.5	0.2	0.0	0.2	0.1	0.2	0.2	0.0	0.0	0.0	1.030
32 Brain	10.7	14.3	2.3	71.4	0.2	0.0	0.4	0.2	0.3	0.3	0.0	0.0	0.0	1.040
33 Heart wall	10.4	13.4	3.0	72.2	0.1	0.0	0.2	0.2	0.2	0.3	0.0	0.0	0.0	1.040
34 Eye lens and bulb	9.6	19.5	5.7	64.6	0.1	0.0	0.1	0.3	0.1	0.0	0.0	0.0	0.0	1.050
35 Kidney tissue	10.3	12.5	3.1	73.1	0.2	0.0	0.2	0.2	0.2	0.2	0.1	0.0	0.0	1.040
36 Stomach wall	10.5	11.4	2.5	74.9	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.0	0.0	1.030
37 Small intestine wall	10.5	11.4	2.5	74.9	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.0	0.0	1.030
38 Colon wall and rectum	10.5	11.4	2.5	74.9	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.0	0.0	1.030
39 Spleen	10.3	11.2	3.2	74.3	0.1	0.0	0.2	0.2	0.2	0.3	0.0	0.0	0.0	1.060
40 Thyroid	10.4	11.8	2.5	74.5	0.2	0.0	0.1	0.1	0.2	0.1	0.0	0.0	0.1	1.050
41 Urinary bladder wall	10.5	9.6	2.6	76.1	0.2	0.0	0.2	0.2	0.3	0.3	0.0	0.0	0.0	1.040
42 Ovaries	10.5	24.5	2.7	61.3	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	0.0	1.050
43 Adrenal glands	10.4	22.6	2.8	63.1	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	0.0	1.030
44 Oesophagus wall	10.4	21.9	2.9	63.8	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	0.0	1.030
45 Generic soft tissue (several organs)	10.5	23.3	2.8	62.5	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	0.0	1.030
46 Uterus & cervix	10.5	28.3	2.5	57.8	0.1	0.0	0.2	0.2	0.1	0.2	0.0	0.0	0.0	1.030
47 Lymphatic nodes	10.5	24.9	2.7	60.9	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	0.0	1.030
48 Breast glandular tissue	11.4	45.6	0.5	42.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.020
49 Adipose tissue	11.4	58.9	0.7	28.6	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.960
50 Lungs tissue	10.2	10.8	3.2	74.7	0.1	0.0	0.1	0.2	0.3	0.2	0.0	0.1	0.0	0.434
51 GI tract contents	10.0	22.2	2.2	64.4	0.1	0.0	0.2	0.3	0.1	0.4	0.1	0.0	0.0	1.030
52 Urine	10.7	0.3	1.0	87.3	0.4	0.0	0.1	0.0	0.0	0.2	0.0	0.0	0.0	1.010
53 Air inside the body	0.0	0.0	75.5	23.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.001

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994 Table B.9. List of media, their elemental compositions (percent by mass), and their mass densities
 995 for the *15-year-old male phantom*.

Medium	H ₁	C ₆	N ₇	O ₈	Na ₁₁	Mg ₁₂	P ₁₅	S ₁₆	Cl ₁₇	K ₁₉	Ca ₂₀	Fe ₂₆	I ₅₃	Density (g/cm ³)
1	Teeth	2.2	9.5	2.9	42.1	0.0	0.7	13.7	0.0	0.0	28.9	0.0	0.0	3.000
2	Mineral bone	3.9	15.9	4.3	45.8	0.2	0.2	9.3	0.3	0.0	20.1	0.0	0.0	1.800
3	Humeri, upper half, spongiosa	9.7	49.1	1.7	32.3	0.1	0.0	2.2	0.2	0.0	0.0	4.6	0.0	1.127
4	Humeri, lower half, spongiosa	11.1	52.2	1.8	34.4	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	1.153
5	Ulnae and radii, spongiosa	11.2	56.4	1.4	30.5	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	1.161
6	Wrists and hand bones, spongiosa	11.4	62.2	0.8	25.2	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	1.078
7	Clavicles, spongiosa	9.5	36.2	3.1	45.4	0.1	0.1	1.8	0.2	0.0	0.0	3.5	0.1	1.142
8	Cranium, spongiosa	8.1	31.6	3.2	45.0	0.1	0.1	3.7	0.2	0.0	0.0	7.8	0.0	1.250
9	Femora upper half, spongiosa	9.3	38.5	2.8	42.4	0.1	0.1	2.1	0.2	0.0	0.0	4.3	0.0	1.167
10	Femora lower half, spongiosa	9.2	45.9	1.9	34.1	0.1	0.1	2.7	0.2	0.0	0.0	5.7	0.0	1.202
11	Tibiae, fibulae, and patellae, spongiosa	9.2	45.4	2.0	34.6	0.1	0.1	2.7	0.2	0.0	0.0	5.7	0.0	1.084
12	Ankles and foot bones, spongiosa	9.3	46.7	1.9	33.6	0.1	0.1	2.6	0.2	0.0	0.0	5.4	0.0	1.078
13	Mandible, spongiosa	8.4	33.0	3.1	44.5	0.1	0.1	3.4	0.2	0.0	0.0	7.1	0.0	1.225
14	Pelvis, spongiosa	10.2	41.6	2.7	42.3	0.1	0.1	0.9	0.2	0.0	0.0	1.7	0.1	1.093
15	Ribs, spongiosa	9.8	37.6	3.0	45.0	0.1	0.1	1.4	0.2	0.0	0.0	2.6	0.1	1.110
16	Scapulae, spongiosa	9.2	34.9	3.1	45.8	0.1	0.1	2.1	0.2	0.0	0.0	4.3	0.1	1.244
17	Cervical spine, spongiosa	9.5	36.5	3.1	45.3	0.1	0.1	1.7	0.2	0.0	0.0	3.3	0.1	1.139
18	Thoracic spine, spongiosa	8.2	32.1	3.1	44.8	0.1	0.1	3.6	0.2	0.0	0.0	7.5	0.0	1.115
19	Lumbar spine, spongiosa	9.2	38.0	2.8	42.3	0.1	0.1	2.3	0.2	0.0	0.0	4.8	0.0	1.098
20	Scapula, spongiosa	9.7	39.2	2.8	43.1	0.1	0.1	1.5	0.2	0.0	0.0	3.0	0.1	1.056
21	Sternum, spongiosa	9.7	37.1	3.0	45.1	0.1	0.1	1.5	0.2	0.0	0.0	3.0	0.1	1.089
22	Humeri and femora, upper half, medullary cavity	8.6	41.6	2.3	36.5	0.1	0.1	3.4	0.2	0.0	0.0	7.2	0.0	0.997
23	Humeri and femora, lower half, medullary cavity	10.0	51.5	1.6	31.0	0.1	0.0	1.8	0.1	0.0	0.0	3.8	0.0	0.990
24	Ulnae and radii, medullary cavity	11.3	58.9	1.1	28.2	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.980
25	Tibiae, fibulae, and patellae, medullary cavity	9.2	46.0	1.9	34.0	0.1	0.1	2.7	0.2	0.0	0.0	5.7	0.0	0.980
26	Cartilage	9.6	9.9	2.2	74.4	0.5	0.0	2.1	0.9	0.3	0.0	0.0	0.0	1.100
27	Skin	10.0	20.0	4.2	65.0	0.2	0.0	0.1	0.2	0.3	0.1	0.0	0.0	1.100
28	Blood vessels	10.2	11.0	3.3	74.5	0.1	0.0	0.1	0.2	0.3	0.2	0.0	0.1	1.060
29	Oral mucosa	10.2	14.2	3.4	71.1	0.1	0.0	0.2	0.3	0.1	0.4	0.0	0.0	1.030
30	Liver	10.3	16.1	3.0	69.5	0.2	0.0	0.2	0.3	0.2	0.3	0.0	0.0	1.050
31	Pancreas	10.5	15.4	2.5	70.7	0.2	0.0	0.2	0.1	0.2	0.2	0.0	0.0	1.030
32	Brain	10.7	14.3	2.3	71.4	0.2	0.0	0.4	0.2	0.3	0.3	0.0	0.0	1.040
33	Heart wall	10.4	13.4	3.0	72.3	0.1	0.0	0.2	0.2	0.2	0.3	0.0	0.0	1.040
34	Eye lens and bulb	9.6	19.5	5.7	64.6	0.1	0.0	0.1	0.3	0.1	0.0	0.0	0.0	1.050
35	Kidney tissue	10.3	12.4	3.1	73.2	0.2	0.0	0.2	0.2	0.2	0.2	0.1	0.0	1.040
36	Stomach wall	10.5	11.3	2.5	74.9	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.0	1.030
37	Small intestine wall	10.5	11.3	2.6	74.9	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.0	1.030
38	Colon wall and rectum	10.5	11.3	2.6	74.9	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.0	1.030
39	Spleen	10.2	11.1	3.3	74.3	0.1	0.0	0.2	0.2	0.3	0.2	0.0	0.1	1.060
40	Thyroid	10.4	11.7	2.6	74.5	0.2	0.0	0.1	0.1	0.2	0.1	0.0	0.1	1.050
41	Urinary bladder wall	10.5	9.6	2.6	76.1	0.2	0.0	0.2	0.2	0.3	0.3	0.0	0.0	1.040
42	Testes	10.6	10.0	2.1	76.5	0.2	0.0	0.1	0.2	0.2	0.2	0.0	0.0	1.050
43	Adrenal glands	10.4	22.0	2.8	63.7	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	1.030
44	Oesophagus wall	10.4	21.2	2.9	64.6	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	1.030
45	Generic soft tissue (several organs)	10.4	22.8	2.8	63.0	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	1.030
46	Prostate	10.4	22.8	2.8	63.0	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	1.030
47	Lymphatic nodes	10.5	24.8	2.7	61.0	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	1.030
48	Breast glandular tissue	11.2	50.4	1.2	36.8	0.1	0.0	0.0	0.1	0.1	0.0	0.0	0.0	1.020
49	Adipose tissue	11.4	58.8	0.8	28.7	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.940
50	Lungs tissue	10.2	10.8	3.2	74.7	0.1	0.0	0.1	0.2	0.3	0.2	0.0	0.1	0.359
51	GI tract contents	10.0	22.2	2.2	64.4	0.1	0.0	0.2	0.3	0.1	0.4	0.1	0.0	1.030
52	Urine	10.7	0.3	1.0	87.3	0.4	0.0	0.1	0.0	0.0	0.2	0.0	0.0	1.010
53	Air inside the body	0.0	0.0	75.5	23.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.001

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998 Table B.10. List of media, their elemental compositions (percent by mass), and their mass densities
 999 for the *15-year-old female phantom*.

Medium	H ₁	C ₆	N ₇	O ₈	Na ₁₁	Mg ₁₂	P ₁₅	S ₁₆	Cl ₁₇	K ₁₉	Ca ₂₀	Fe ₂₆	I ₅₃	Density (g/cm ³)
1	Teeth	2.2	9.5	2.9	42.1	0.0	0.7	13.7	0.0	0.0	28.9	0.0	0.0	3.000
2	Mineral bone	3.9	15.9	4.3	45.8	0.2	0.2	9.3	0.3	0.0	0.0	20.1	0.0	1.800
3	Humeri, upper half, spongiosa	9.7	48.7	1.7	32.7	0.1	0.0	2.2	0.2	0.0	0.0	4.6	0.0	1.127
4	Humeri, lower half, spongiosa	11.0	51.3	1.8	35.3	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	1.152
5	Ulnae and radii, spongiosa	11.2	55.8	1.4	31.1	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	1.160
6	Wrists and hand bones, spongiosa	11.4	61.9	0.8	25.5	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	1.077
7	Clavicles, spongiosa	9.5	35.2	3.1	46.5	0.1	0.1	1.7	0.2	0.1	0.0	3.4	0.1	1.142
8	Cranium, spongiosa	8.2	31.0	3.2	45.9	0.1	0.1	3.6	0.2	0.1	0.0	7.6	0.0	1.253
9	Femora upper half, spongiosa	9.4	37.6	2.8	43.4	0.1	0.1	2.1	0.2	0.0	0.0	4.2	0.0	1.166
10	Femora lower half, spongiosa	9.2	45.5	2.0	34.5	0.1	0.1	2.7	0.2	0.0	0.0	5.7	0.0	1.202
11	Tibiae, fibulae, and patellae, spongiosa	9.2	45.0	2.0	35.0	0.1	0.1	2.7	0.2	0.0	0.0	5.6	0.0	1.084
12	Ankles and foot bones, spongiosa	9.3	46.3	1.9	34.1	0.1	0.1	2.6	0.2	0.0	0.0	5.4	0.0	1.077
13	Mandible, spongiosa	8.4	32.3	3.1	45.3	0.1	0.1	3.3	0.2	0.1	0.0	6.9	0.0	1.225
14	Pelvis, spongiosa	10.2	40.6	2.7	43.4	0.1	0.1	0.9	0.2	0.0	0.0	1.6	0.1	1.092
15	Ribs, spongiosa	9.8	36.6	3.0	46.1	0.1	0.1	1.3	0.2	0.1	0.0	2.6	0.1	1.109
16	Scapulae, spongiosa	9.2	34.0	3.2	46.8	0.1	0.1	2.1	0.2	0.1	0.0	4.2	0.1	1.243
17	Cervical spine, spongiosa	9.5	35.5	3.1	46.4	0.1	0.1	1.6	0.2	0.1	0.0	3.2	0.1	1.139
18	Thoracic spine, spongiosa	8.2	31.5	3.2	45.7	0.1	0.1	3.5	0.2	0.1	0.0	7.3	0.0	1.115
19	Lumbar spine, spongiosa	9.2	37.2	2.8	43.2	0.1	0.1	2.3	0.2	0.0	0.0	4.7	0.0	1.098
20	Scapulae, spongiosa	9.7	38.2	2.9	44.2	0.1	0.1	1.5	0.2	0.1	0.0	2.9	0.1	1.055
21	Sternum, spongiosa	9.7	36.1	3.1	46.2	0.1	0.1	1.5	0.2	0.1	0.0	2.9	0.1	1.088
22	Humeri and femora, upper half, medullary cavity	8.7	41.1	2.3	37.0	0.1	0.1	3.4	0.2	0.0	0.0	7.1	0.0	0.997
23	Humeri and femora, lower half, medullary cavity	10.0	51.1	1.6	31.4	0.1	0.0	1.8	0.1	0.0	0.0	3.8	0.0	0.990
24	Ulnae and radii, medullary cavity	11.3	58.5	1.2	28.6	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.980
25	Tibiae, fibulae, and patellae, medullary cavity	9.3	45.6	2.0	34.5	0.1	0.1	2.7	0.2	0.0	0.0	5.6	0.0	0.980
26	Cartilage	9.6	9.9	2.2	74.4	0.5	0.0	2.2	0.9	0.3	0.0	0.0	0.0	1.100
27	Skin	10.0	20.0	4.2	64.9	0.2	0.0	0.1	0.2	0.3	0.1	0.0	0.0	1.100
28	Blood vessels	10.2	11.0	3.3	74.5	0.1	0.0	0.1	0.2	0.3	0.2	0.0	0.1	1.060
29	Oral mucosa	10.2	14.2	3.4	71.1	0.1	0.0	0.2	0.3	0.1	0.4	0.0	0.0	1.020
30	Liver	10.3	16.5	2.9	69.1	0.2	0.0	0.2	0.3	0.2	0.3	0.0	0.0	1.050
31	Pancreas	10.5	15.8	2.4	70.4	0.2	0.0	0.2	0.1	0.2	0.2	0.0	0.0	1.020
32	Brain	10.7	14.4	2.2	71.3	0.2	0.0	0.4	0.2	0.3	0.3	0.0	0.0	1.040
33	Heart wall	10.4	13.5	3.0	72.2	0.1	0.0	0.2	0.2	0.2	0.3	0.0	0.0	1.040
34	Eye lens and bulb	9.6	19.5	5.7	64.6	0.1	0.0	0.1	0.3	0.1	0.0	0.0	0.0	1.050
35	Kidney tissue	10.3	12.6	3.1	73.0	0.2	0.0	0.2	0.2	0.2	0.2	0.1	0.0	1.040
36	Stomach wall	10.5	11.4	2.4	75.0	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.0	1.030
37	Small intestine wall	10.5	11.4	2.5	75.0	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.0	1.030
38	Colon wall and rectum	10.5	11.4	2.5	75.0	0.1	0.0	0.1	0.1	0.2	0.1	0.0	0.0	1.030
39	Spleen	10.3	11.2	3.2	74.3	0.1	0.0	0.2	0.2	0.2	0.3	0.0	0.0	1.060
40	Thyroid	10.4	11.8	2.5	74.5	0.2	0.0	0.1	0.1	0.2	0.1	0.0	0.1	1.050
41	Urinary bladder wall	10.5	9.6	2.6	76.1	0.2	0.0	0.2	0.2	0.3	0.3	0.0	0.0	1.040
42	Ovaries	10.5	24.6	2.7	61.2	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	1.050
43	Adrenal glands	10.4	23.0	2.8	62.7	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	1.020
44	Oesophagus wall	10.4	22.4	2.8	63.3	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	1.030
45	Generic soft tissue (several organs)	10.5	24.5	2.7	61.3	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	1.020
46	Uterus & cervix	10.6	29.9	2.5	56.2	0.1	0.0	0.2	0.2	0.1	0.2	0.0	0.0	1.030
47	Lymphatic nodes	10.5	25.0	2.7	60.8	0.1	0.0	0.2	0.3	0.2	0.2	0.0	0.0	1.020
48	Breast glandular tissue	11.5	48.8	0.3	39.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.020
49	Adipose tissue	11.4	59.0	0.7	28.6	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.940
50	Lungs tissue	10.2	10.8	3.2	74.7	0.1	0.0	0.1	0.2	0.3	0.2	0.0	0.1	0.305
51	GI tract contents	10.0	22.2	2.2	64.4	0.1	0.0	0.2	0.3	0.1	0.4	0.1	0.0	1.020
52	Urine	10.7	0.3	1.0	87.3	0.4	0.0	0.1	0.0	0.0	0.2	0.0	0.0	1.010
53	Air inside the body	0.0	0.0	75.5	23.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.001

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ANNEX C. LIST OF SOURCE REGIONS, ACRONYMS, AND ID NUMBERS

1003 (C 1) Table C.1 establishes a set of acronyms for the source regions for the calculation of
1004 specific absorbed fractions. The regions of the Human Alimentary Tract Model and the Human
1005 Respiratory Tract Model are listed first, followed by the systemic regions. The third column gives
1006 the ID numbers in the phantoms that make up the respective region or – if these are too many – a
1007 footnote to this table where the sub-division of the region is expanded in detail.

1008 Table C.1. Source regions, acronyms, and corresponding ID numbers in the paediatric phantoms.

Source region	Acronym	ID Numbers
Oral cavity	O-cavity	5, 6
Oral mucosa	O-mucosa	5, 6
Teeth surfact activity	Teeth-S	128
Teeth volume activity	Teeth-V	128
Tongue	Tongue	5, 133*
Tonsils	Tonsils	134
Oesophagus fast	Oesophagus-f	110
Oesophagus slow	Oesophagus-s	110
Oesophagus wall	Oesophagus	110
Stomach contents	St-cont	73
Stomach wall	St-wall	72
Small intestine contents	SI-cont	75
Small intestine wall	SI-wall	74
Right colon contents	RC-cont	77, 79
Right colon wall	RC-wall	76, 78
Left colon contents	LC-cont	81, 83
Left colon wall	LC-wall	80, 82
Rectosigmoid colon contents	Rsig-cont	85
Rectosigmoid colon wall	Rsig-wall	84, 86
Surface of anterior nasal passages	ET1-sur	3
Surface of posterior nasal passages + pharynx	ET2-sur	4
Sequestered ET ₂ region	ET2-seq	4
Lymph nodes in ET region	LN-ET	100
Bronchi fast	Bronchi-f	7, 8
Bronchi slow	Bronchi-s	7, 8
Bronchi bound	Bronchi-b	7, 8
Bronchi sequestered	Bronchi-q	7, 8
Bronchioles fast	Brchiole-f	97, 99
Bronchioles slow	Brchiole-s	97, 99
Bronchioles bound	Brchiole-b	97, 99
Bronchioles sequestered	Brchiole-q	97, 99
Alveolar-interstitium	AI	97, 99
Lymph nodes in TH region	LN-Th	101
Right lung lobe	Rlung	98, 99
Left lung lobe	Llung	96, 97
Right Lung + Left Lung	Lungs	96 - 99
Right adrenal gland	RAdrenal	2
Left adrenal gland	LAdrenal	1
Right and left adrenal glands	Adrenals	1, 2
Blood vessels of head	HBlood	9
Blood vessels of trunk	TBlood	10
Blood vessels of arms	ABlood	11
Blood vessels of legs	LBlood	12
Blood in heart	Ht-cont	88
Total blood	Blood	†
Cortical bone, mineral surface	C-bone-S	‡
Cortical bone, mineral volume	C-bone-V	‡
Trabecular bone, mineral surface	T-bone-S	§
Trabecular bone, mineral volume	T-bone-V	§
Cortical bone marrow	C-marrow	¶
Trabecular bone marrow	T-marrow	**

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1011 Table C.1. (continued)

Source region	Acronym	ID Numbers
Brain	Brain	61
Right breast adipose	RBreast-a	64
Right breast glandular	RBreast-g	65
Left breast adipose	LBreast-a	62
Left breast glandular	LBreast-g	63
Right breast adipose + glandular	RBreast	64, 65
Left breast adipose + glandular	LBreast	62, 63
Right and left breast adipose	Breast-a	62, 64
Right and left breast glandular	Breast-g	63, 65
Right and left breast adipose + glandular	Breast	62 - 65
Lens of eyes	Eye-lens	66, 68
Gall bladder wall	GB-wall	70
Gall bladder contents	GB-cont	71
Heart wall	Ht-wall	87
Right kidney cortex	RKidney-C	92
Right kidney medulla	RKidney-M	93
Right kidney pelvis	RKidney-P	94
Right kidney total	Rkidney	92 - 94
Left kidney cortex	LKidney-C	89
Left kidney medulla	LKidney-M	90
Left kidney pelvis	LKidney-P	91
Left kidney total	Lkidney	89 - 91
Right and left kidney	Kidneys	89 - 94
Liver	Liver	95
Lymph nodes, systemic	Lymph	102 - 105
Muscle	Muscle	106 - 109
Right ovary	ROvary	112
Left ovary	LOvary	111
Right and left ovaries	Ovaries	111, 112
Pancreas	Pancreas	113
Pituitary gland	P-gland	114
Prostate gland	Prostate	115
Salivary glands	S-glands	120, 121
Skin	Skin	112 - 125
Spinal cord	Sp-cord	126
Spleen	Spleen	127
Testes	Testes	129, 130
Thymus	Thymus	131
Thyroid	Thyroid	132
Ureters	Ureters	135, 136
Urinary bladder wall	UB-wall	137
Urinary bladder contents	UB-cont	138
Uterus/cervix	Uterus	139
Adipose / residual tissue	Adipose	62, 64, 116 - 119
Total body tissues (less walled organ contents)	T-body	++
Soft tissues (total body tissues less mineral bone)	S-tissue	##

* The surface voxels of the tongue have been segmented as "oral cavity, tongue".

They are considered for both source regions - oral cavity as well as tongue.

† Blood: 9-12, 88, 96, 98, plus blood contained within the organs and tissues

‡ Cortical bone mineral: 13, 16, 19, 22, 24, 26, 28, 31, 34, 37, 39, 41, 43, 45, 47, 49, 51, 53, 55.

§ Trabecular bone mineral: mineral bone fraction of 14, 17, 20, 23, 25, 27, 29, 32, 35, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56.

¶ Cortical bone marrow: 15, 18, 21, 30, 33, 36

** Trabecular bone marrow: marrow fraction of 14, 17, 20, 23, 25, 27, 29, 32, 35, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56 (red and yellow marrow)

†† Total body tissues: 1-70, 72, 74, 76, 78, 80, 82, 84, 86-137, 139.

‡‡ Soft tissue: 1-12, 15, 18, 21, 30, 33, 36, 57-70, 72, 74, 76, 78, 80, 82, 84, 86-127, 129-137, 139

plus the soft tissue fraction of 14, 17, 20, 23, 25, 27, 29, 32, 35, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56.

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ANNEX D. LIST OF TARGET REGIONS, ACRONYMS, AND ID NUMBERS

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(D 1) Table D.1 establishes a set of acronyms for the target regions. The organs contributing to effective dose are listed first, followed by the regions of the Human Alimentary Tract Model, the Human Respiratory Tract Model, and the systemic regions. The third column gives the ID numbers in the phantoms that make up the respective tissue or – if these are too many – a footnote to this table where the sub-division of the tissue is expanded in detail.

1021 Table D.1. Target regions, acronyms, and corresponding ID numbers in the paediatric phantoms.

Source region	Acronym	ID Numbers
Active (red) marrow	R-marrow	*
Colon	Colon	76, 78, 80, 84, 86
Right Lung + Left Lung	Lungs	96 - 99
Stomach wall	St-wall	72
Right and left breast adipose + glandular	Breast	62 - 65
Right and left ovaries	Ovaries	111, 112
Testes	Testes	129, 130
Urinary bladder wall	UB-wall	137
Oesophagus wall	Oesophagus	110
Liver	Liver	95
Thyroid	Thyroid	132
Endosteum, skeletal	Endost-BS	†
Brain	Brain	61
Salivary glands	S-glands	120, 121
Skin	Skin	112 - 125
Right and left adrenal glands	Adrenals	1, 2
ET region	ET	3, 4
Gall bladder wall	GB-wall	70
Heart wall	Ht-wall	87
Right and left kidney	Kidneys	89 - 94
Lymph nodes, systemic	Lymph	102 - 105
Muscle	Muscle	106 - 109
Oral mucosa	O-mucosa	5, 6
Pancreas	Pancreas	113
Prostate gland	Prostate	115
Small intestine wall	SI-wall	74
Spleen	Spleen	127
Thymus	Thymus	131
Uterus/cervix	Uterus	139
Tongue	Tongue	5, 133*
Tonsils	Tonsils	134
Right colon wall (ascending & right transverse)	RC-wall	76, 78
Left colon wall (left transverse & descending)	LC-wall	80, 82
Rectosigmoid colon wall	Rsig-wall	84, 86
Basal cells of anterior nasal passages	ET1-bas	3
Basal cells of posterior nasal passages + pharynx	ET2-bas	4
Lymph nodes in ET region	LN-ET	100
Basal cells of bronchi	Bronchi-bas	8
Secretary cells of bronchi	Bronchi-sec	8
Secretary cells of bronchioles	Brchiol-sec	96 - 99
Alveolar-interstitium	AI	97, 99
Lymph nodes in TH region	LN-Th	101
Right lung lobe	Rlung	98, 99
Left lung lobe	Llung	96, 97
Right adrenal gland	RAdrenal	2
Left adrenal gland	LAdrenal	1
Right breast adipose	RBreast-a	64
Right breast glandular	RBreast-g	65
Left breast adipose	LBreast-a	62
Left breast glandular	LBreast-g	63

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1024 Table D.1. (continued)

Source region	Acronym	ID Numbers
Right breast adipose + glandular	RBreast	64, 65
Left breast adipose + glandular	LBreast	62, 63
Right and left breast adipose	Breast-a	62, 64
Right and left breast glandular	Breast-g	63, 65
Lens of eyes	Eye-lens	66, 68
Right kidney cortex	RKidney-C	92
Right kidney medulla	RKidney-M	93
Right kidney pelvis	RKidney-P	94
Right kidney total	Rkidney	92 - 94
Left kidney cortex	LKidney-C	89
Left kidney medulla	LKidney-M	90
Left kidney pelvis	LKidney-P	91
Left kidney total	Lkidney	89 - 91
Right ovary	ROvary	112
Left ovary	LOvary	111
Pituitary gland	P-gland	114
Spinal cord	Sp-cord	126
Ureters	Ureters	135, 136
Adipose / residual tissue	Adipose	62, 64, 116 - 119

ET - extrathoracic

TH - thoracic

* Red bone marrow fraction in organ IDs 14, 17, 20, 23, 25, 27, 29, 32, 35, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56.

† Endosteum fraction in organ IDs 14, 15, 17, 18, 20, 21, 23, 25, 27, 29, 30, 32, 33, 35, 36, 38, 40, 42, 44, 46, 48, 50, 52, 54, 56.

1025

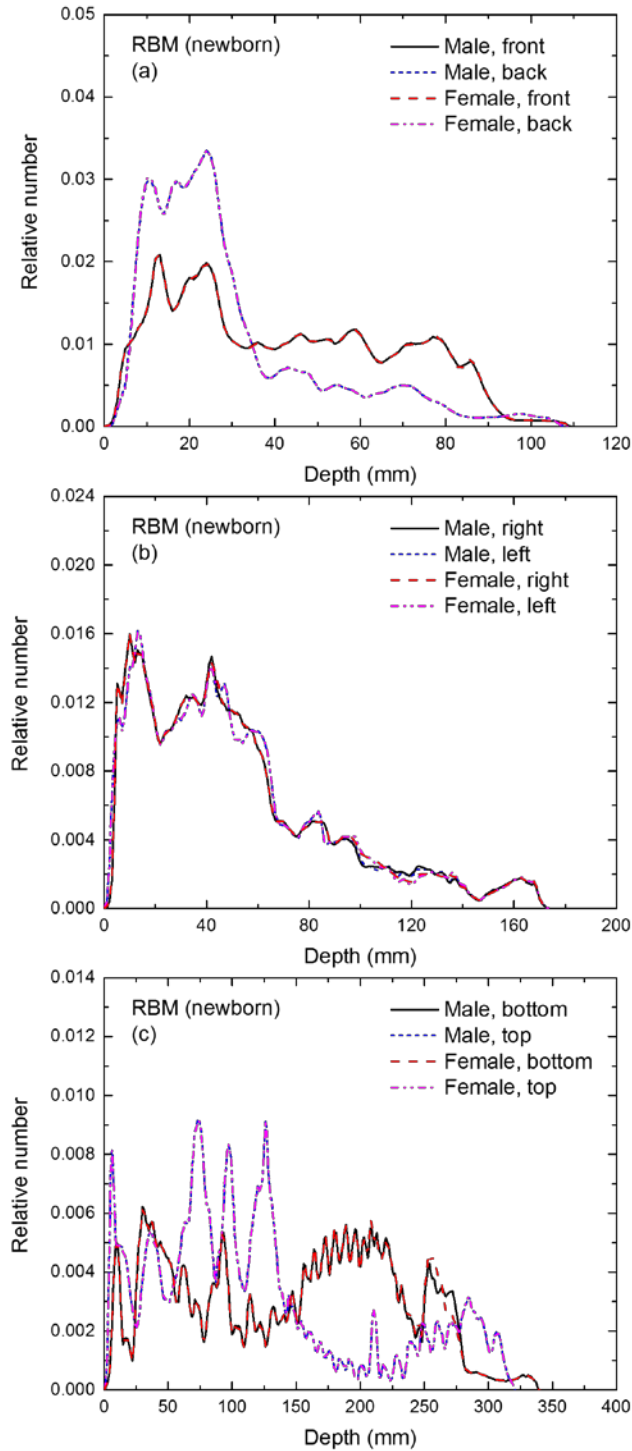
1026
1027**ANNEX E. DISTRIBUTIONS OF DEPTHS OF SELECTED
ORGANS/TISSUES**

1028 (E 1) In Figs. E.1–E.78, depth distributions below the body surfaces at the front, back, right,
1029 left, bottom, and top of the reference paediatric phantoms are shown for those organs and tissues
1030 that contribute to effective dose with specific tissue weighting factors, except the endosteal tissues
1031 for which no geometrical representation is available in the reference computational phantoms.

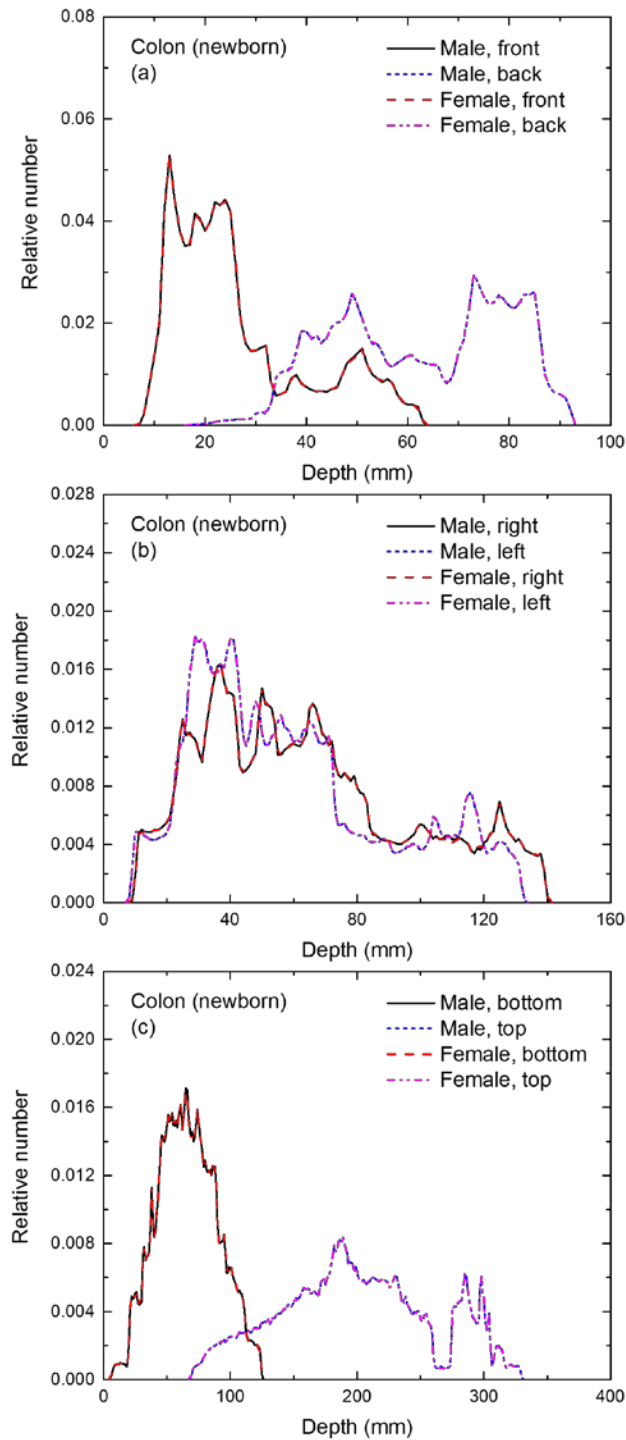
1032 (E 2) The distributions have been evaluated for 10 million points sampled randomly in the
1033 organs considered. Due to the curved surface of the body, these depths are not below planar, but
1034 below uneven surfaces. They indicate the amount of overlying tissue by which each point of an
1035 organ or tissue is shielded from radiation impinging from the front, back, left, right, top, or bottom.

1036 (E 3) Together with the attenuation properties of the overlying tissues and the organ
1037 considered, the depth below the surface is a parameter that significantly influences the dose
1038 coefficients from external radiation.

1039

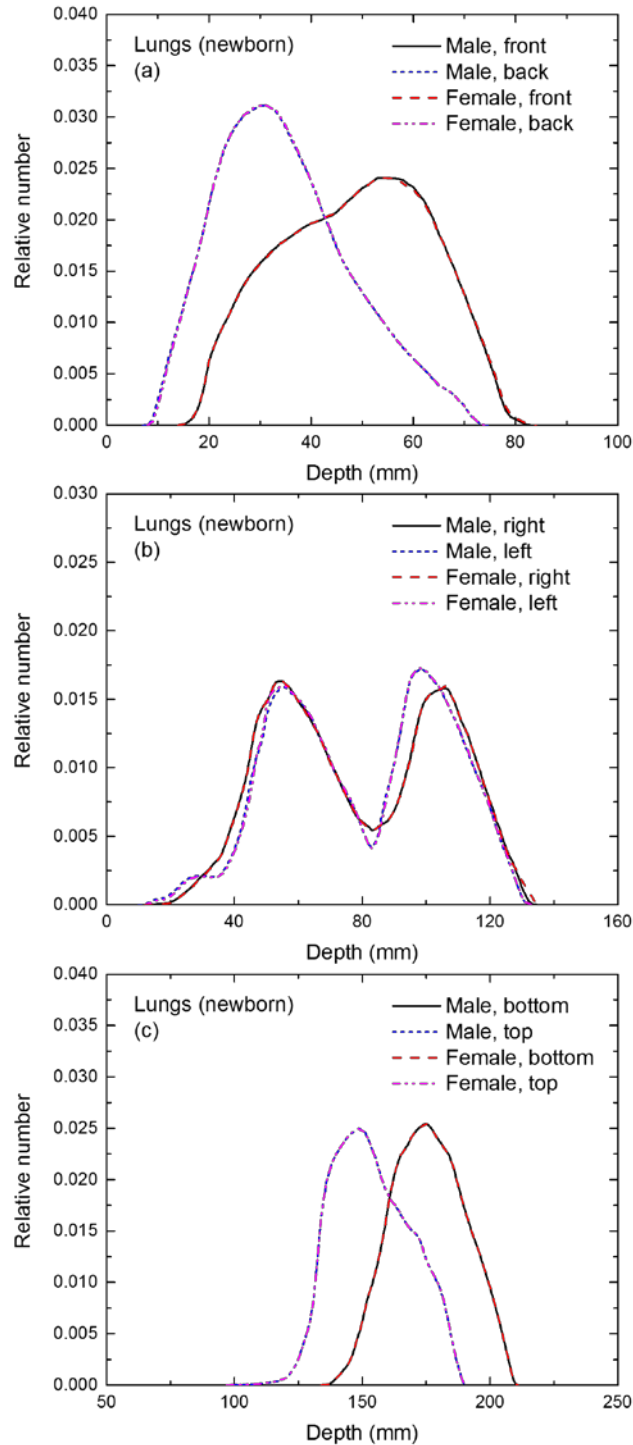


1040
 1041 Fig. E.1. Distribution of depths of 10 million randomly sampled points in the *red bone marrow*
 1042 below the body surface of the *newborn male/female phantoms* at: (a) front and back, (b) right and
 1043 left, and (c) bottom and top.



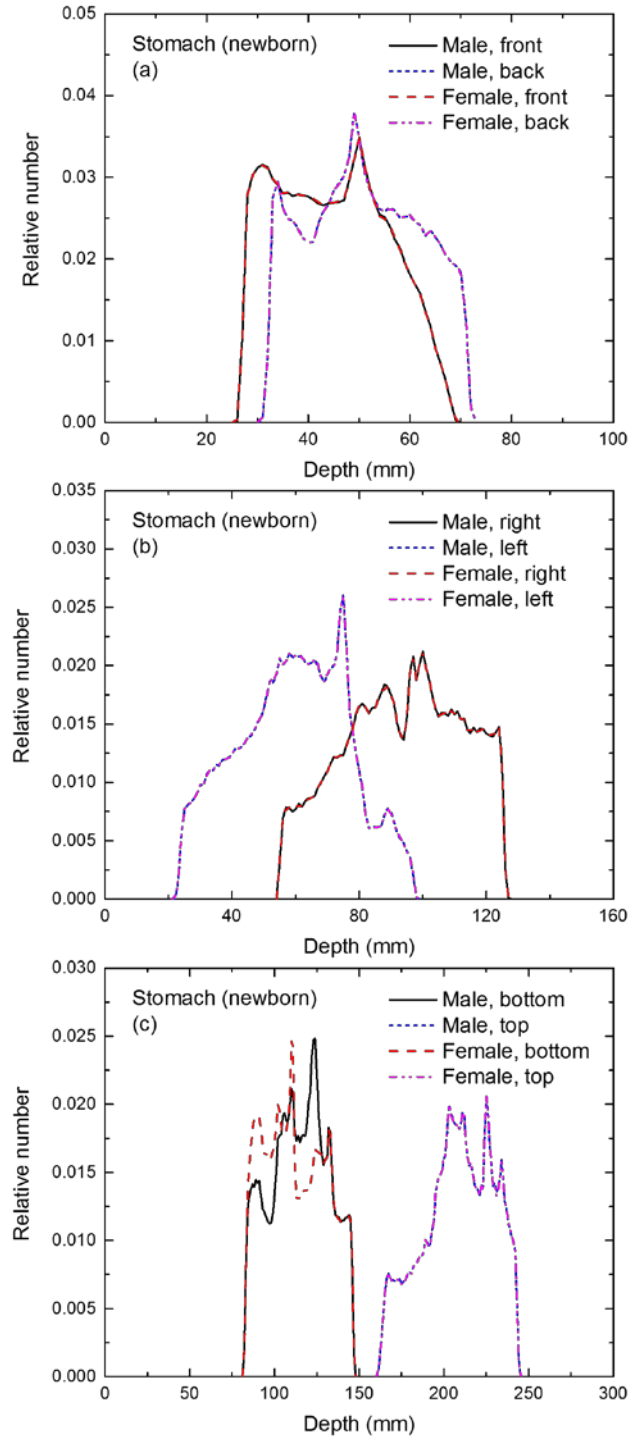
1044

1045 Fig. E.2. Distribution of depths of 10 million randomly sampled points in the *colon wall* below the
 1046 body surface of the *newborn male/female phantoms* at: (a) front and back, (b) right and left, and
 1047 (c) bottom and top.



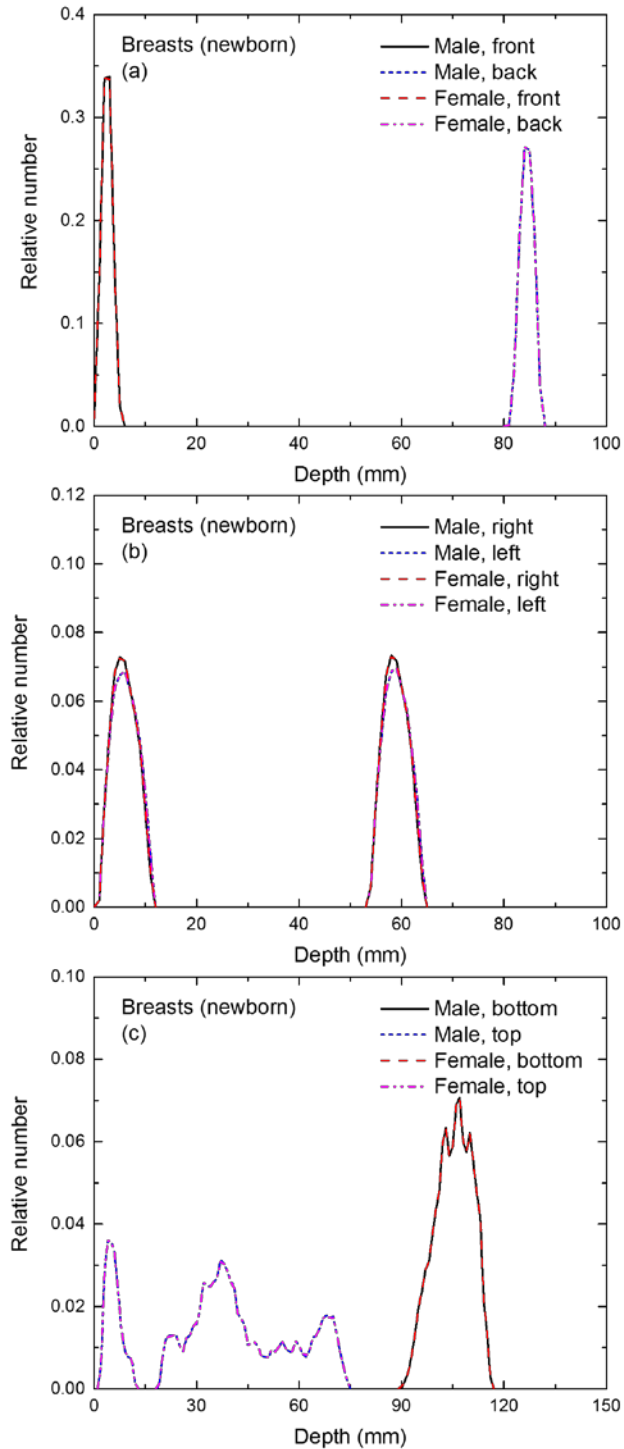
1048

1049 Fig. E.3. Distribution of depths of 10 million randomly sampled points in the *lungs* below the body
 1050 surface of the *newborn male/female phantoms* at: (a) front and back, (b) right and left, and (c)
 1051 bottom and top.



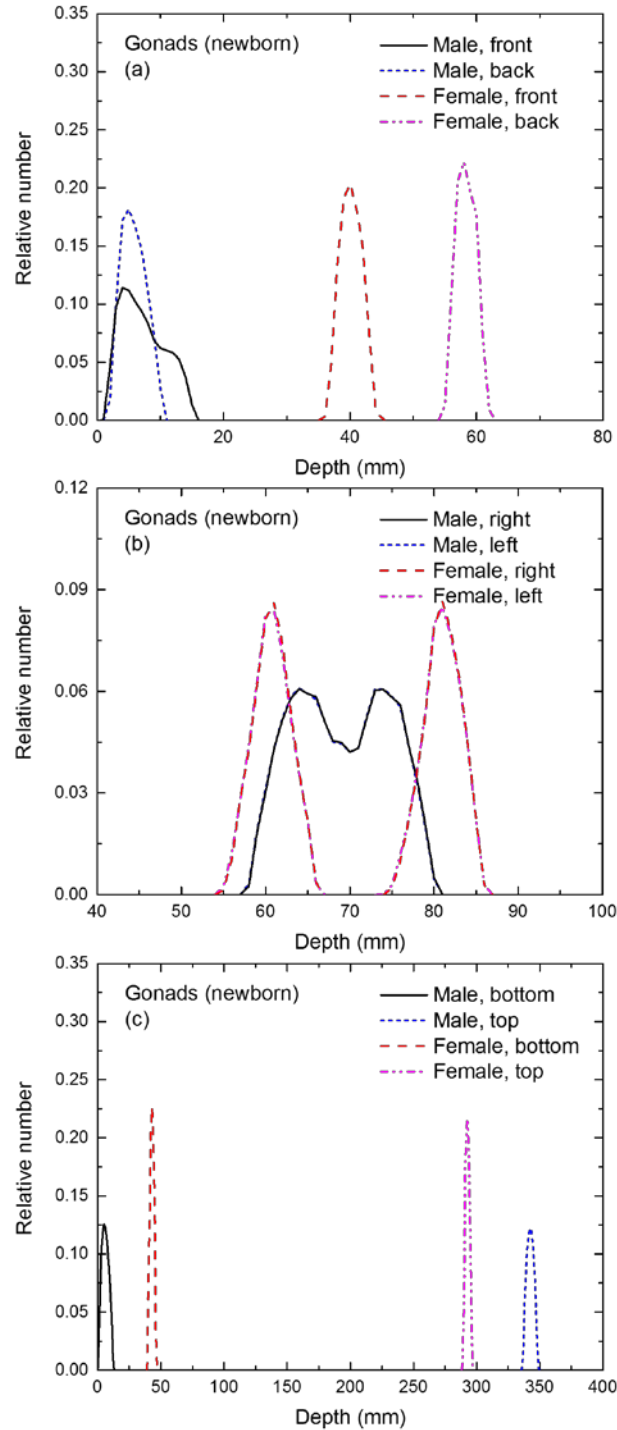
1052

1053 Fig. E.4. Distribution of depths of 10 million randomly sampled points in the *stomach wall* below
 1054 the body surface of the *newborn male/female phantoms* at: (a) front and back, (b) right and left,
 1055 and (c) bottom and top.



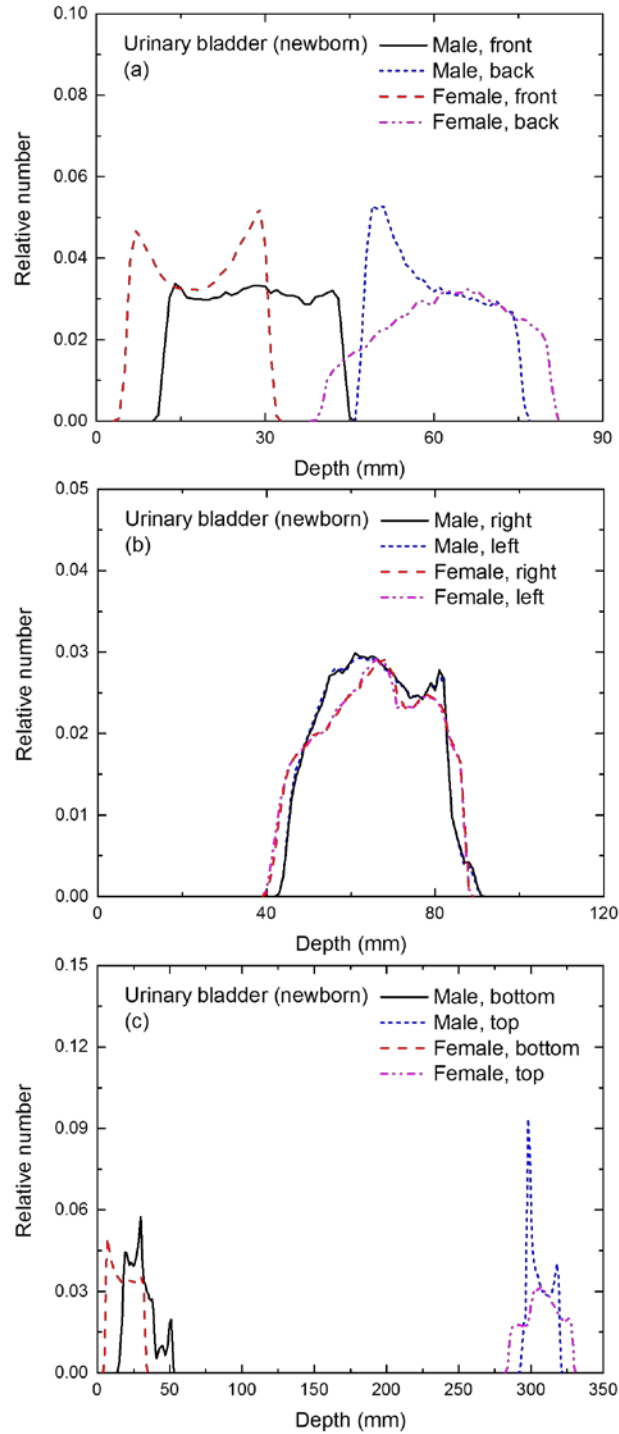
1056

1057 Fig. E.5. Distribution of depths of 10 million randomly sampled points in the *breasts* below the
 1058 body surface of the *newborn male/female phantoms* at: (a) front and back, (b) right and left, and
 1059 (c) bottom and top.



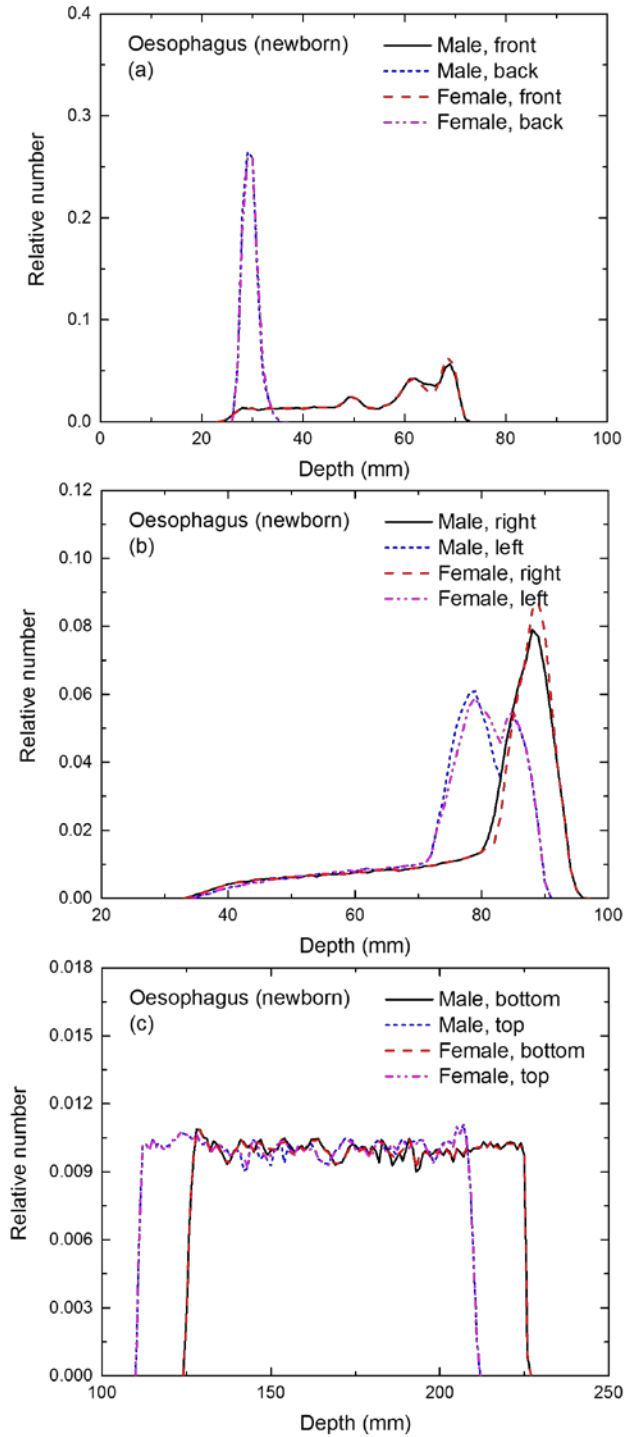
1060

1061 Fig. E.6. Distribution of depths of 10 million randomly sampled points in the *gonads* below the
 1062 body surface of the *newborn male/female phantoms* at: (a) front and back, (b) right and left, and
 1063 (c) bottom and top.



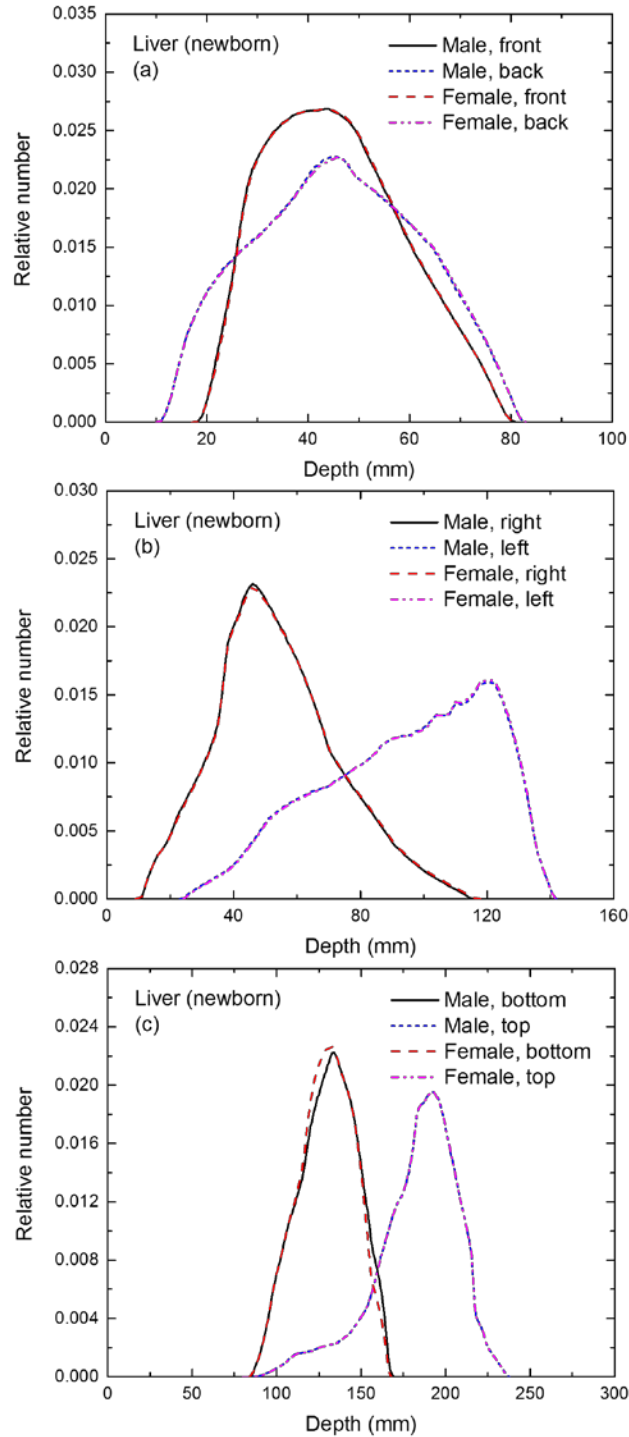
1064

1065 Fig. E.7. Distribution of depths of 10 million randomly sampled points in the *urinary bladder wall*
 1066 below the body surface of the *newborn male/female phantoms* at: (a) front and back, (b) right and
 1067 left, and (c) bottom and top.



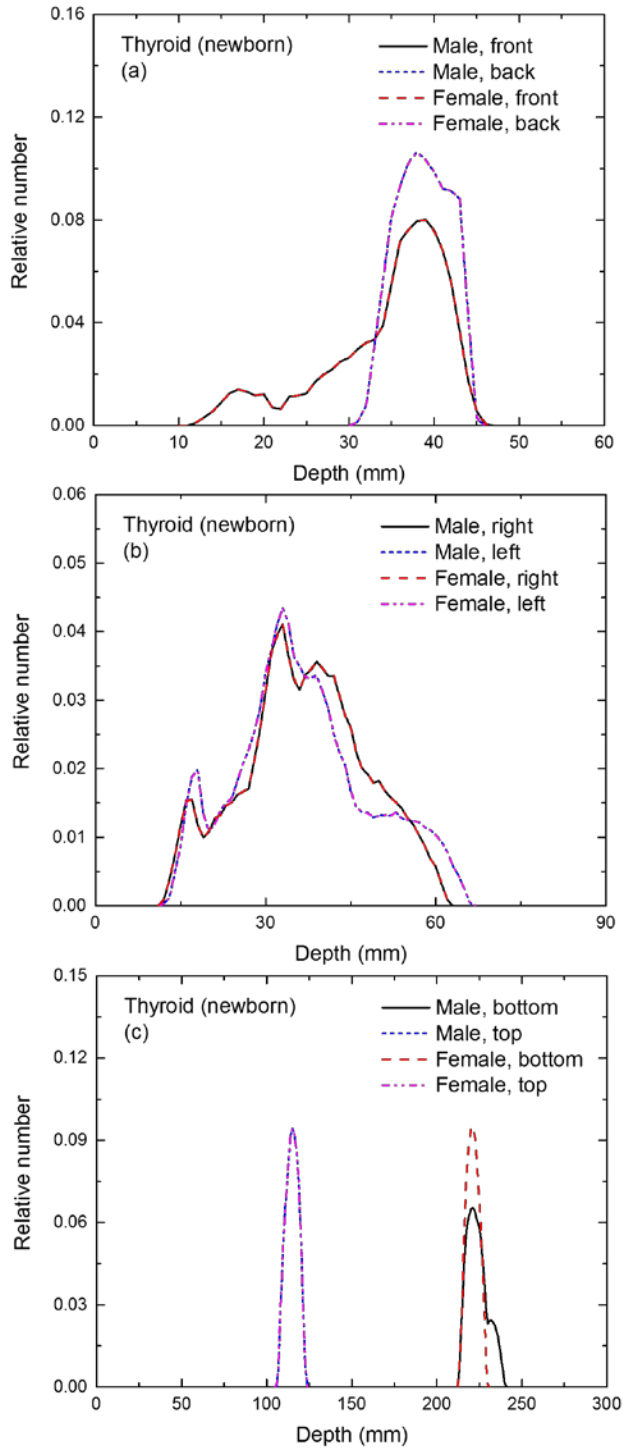
1068

1069 Fig. E.8. Distribution of depths of 10 million randomly sampled points in the *oesophagus wall*
 1070 below the body surface of the *newborn male/female phantoms* at: (a) front and back, (b) right and
 1071 left, and (c) bottom and top.



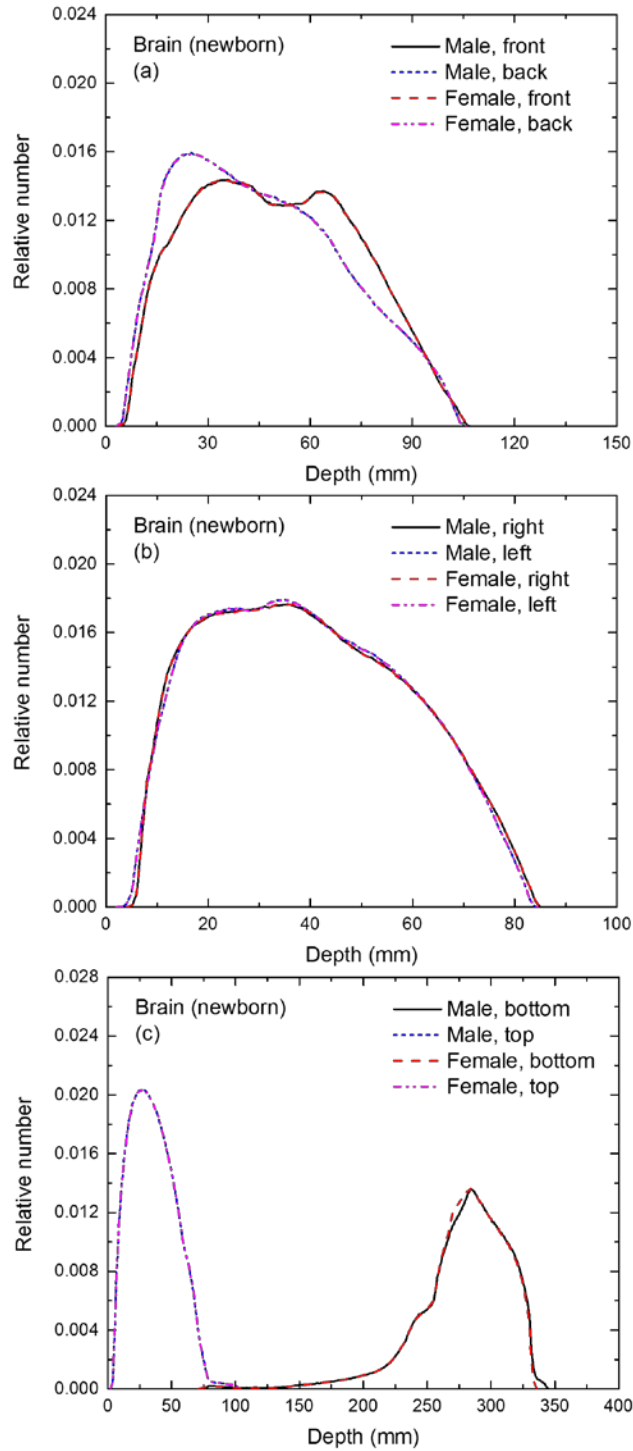
1072

1073 Fig. E.9. Distribution of depths of 10 million randomly sampled points in the *liver* below the body
 1074 surface of the *newborn male/female phantoms* at: (a) front and back, (b) right and left, and (c)
 1075 bottom and top.



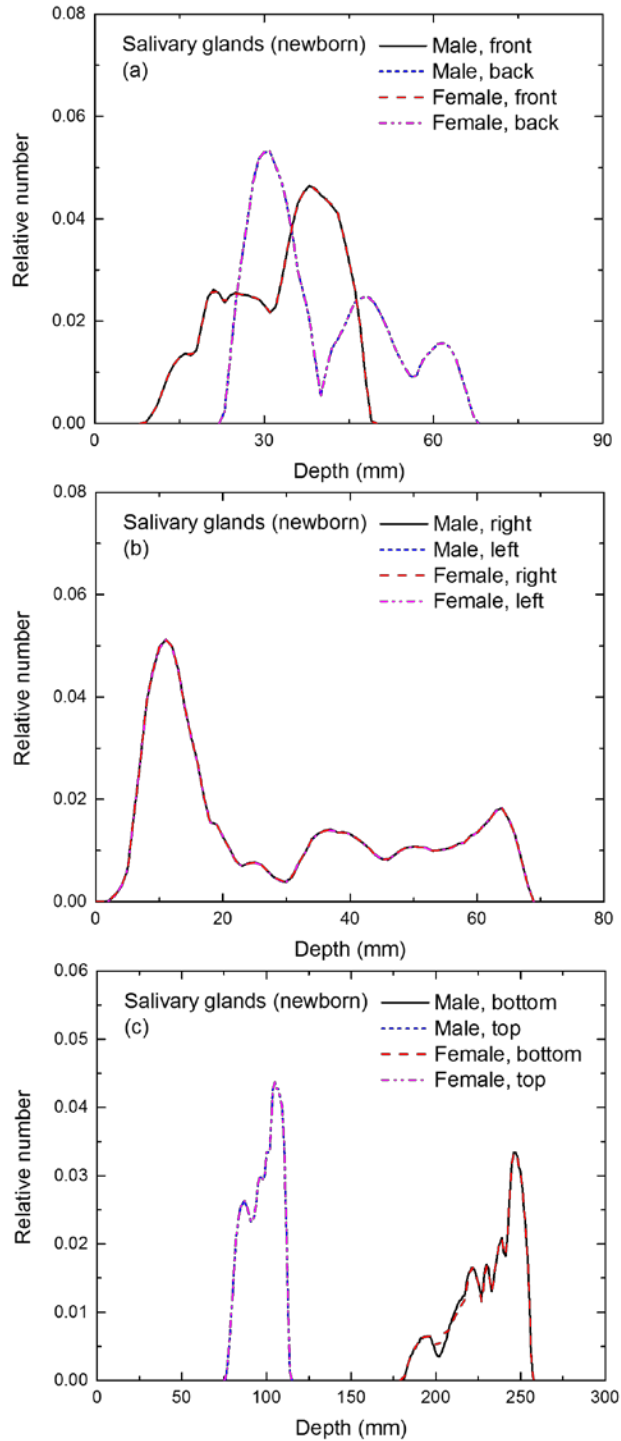
1076

1077 Fig. E.10. Distribution of depths of 10 million randomly sampled points in the *thyroid* below the
 1078 body surface of the *newborn male/female phantoms* at: (a) front and back, (b) right and left, and
 1079 (c) bottom and top.



1080

1081 Fig. E.11. Distribution of depths of 10 million randomly sampled points in the *brain* below the
 1082 body surface of the *newborn male/female phantoms* at: (a) front and back, (b) right and left, and
 1083 (c) bottom and top.

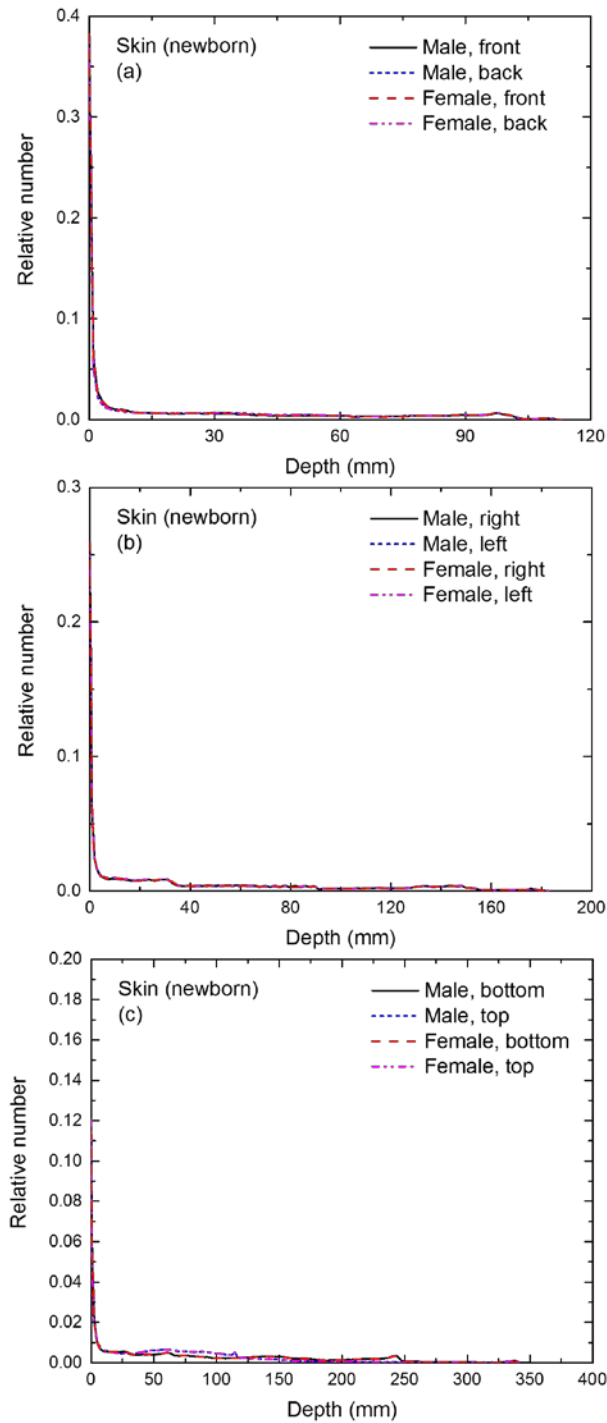


1084

1085 Fig. E.12. Distribution of depths of 10 million randomly sampled points in the *salivary glands*

1086 below the body surface of the *newborn male/female phantoms* at: (a) front and back, (b) right and

1087 left, and (c) bottom and top.



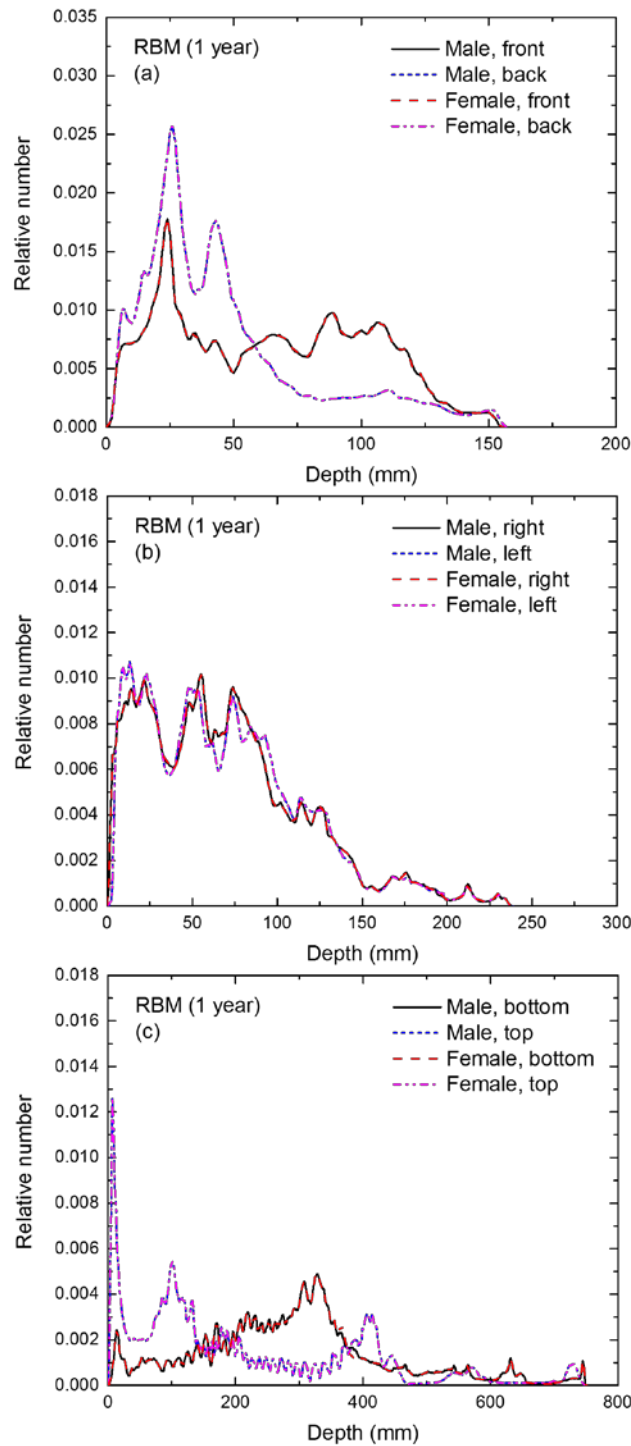
1088

1089 Fig. E.13. Distribution of depths of 10 million randomly sampled points in the *skin* below the body

1090 surface of the *newborn male/female phantoms* at: (a) front and back, (b) right and left, and (c)

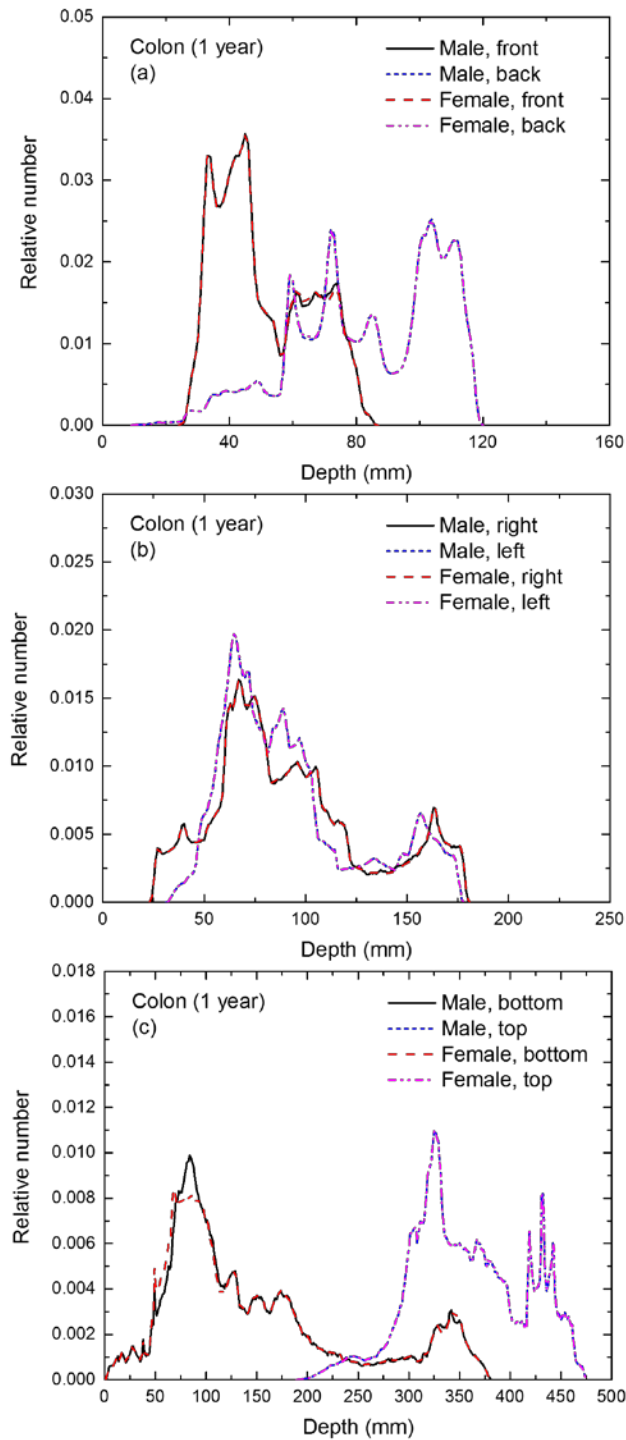
1091 bottom and top.

1092



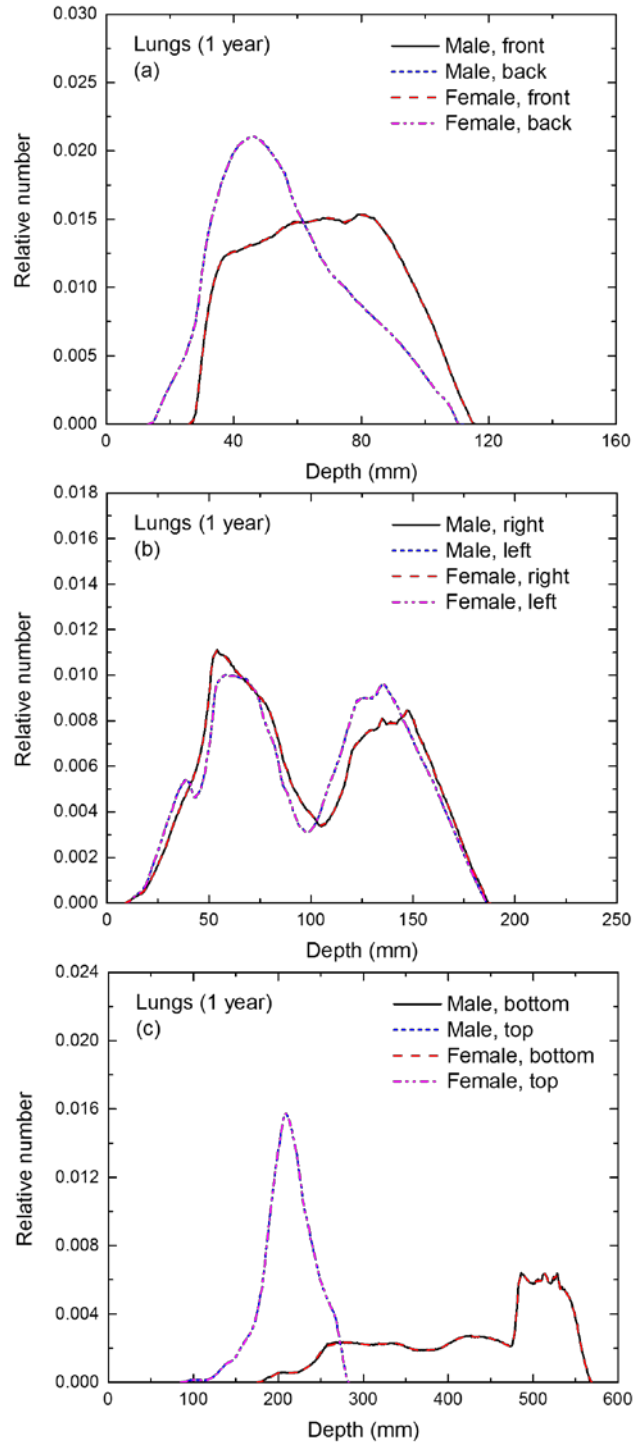
1093

1094 Fig. E.14. Distribution of depths of 10 million randomly sampled points in the *red bone marrow*
 1095 below the body surface of the *1-year-old male/female phantoms* at: (a) front and back, (b) right
 1096 and left, and (c) bottom and top.



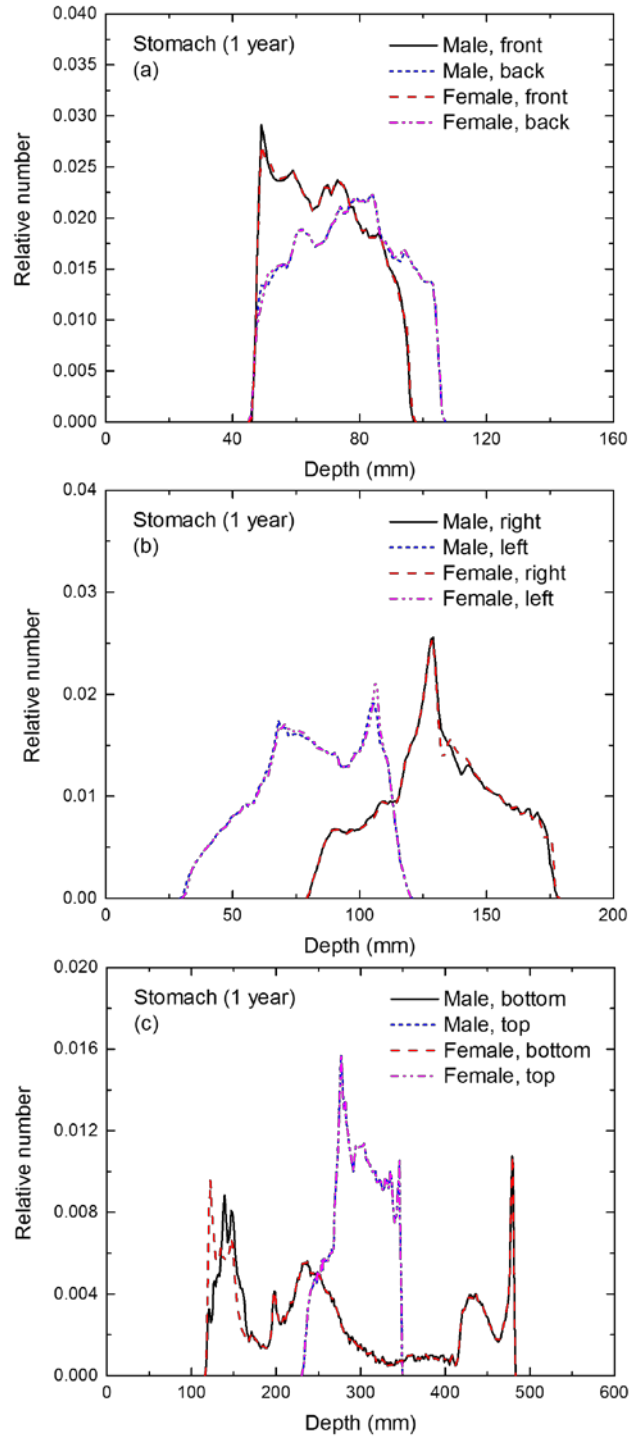
1097

1098 Fig. E.15. Distribution of depths of 10 million randomly sampled points in the *colon wall* below
 1099 the body surface of the *1-year-old male/female phantoms* at: (a) front and back, (b) right and left,
 1100 and (c) bottom and top.



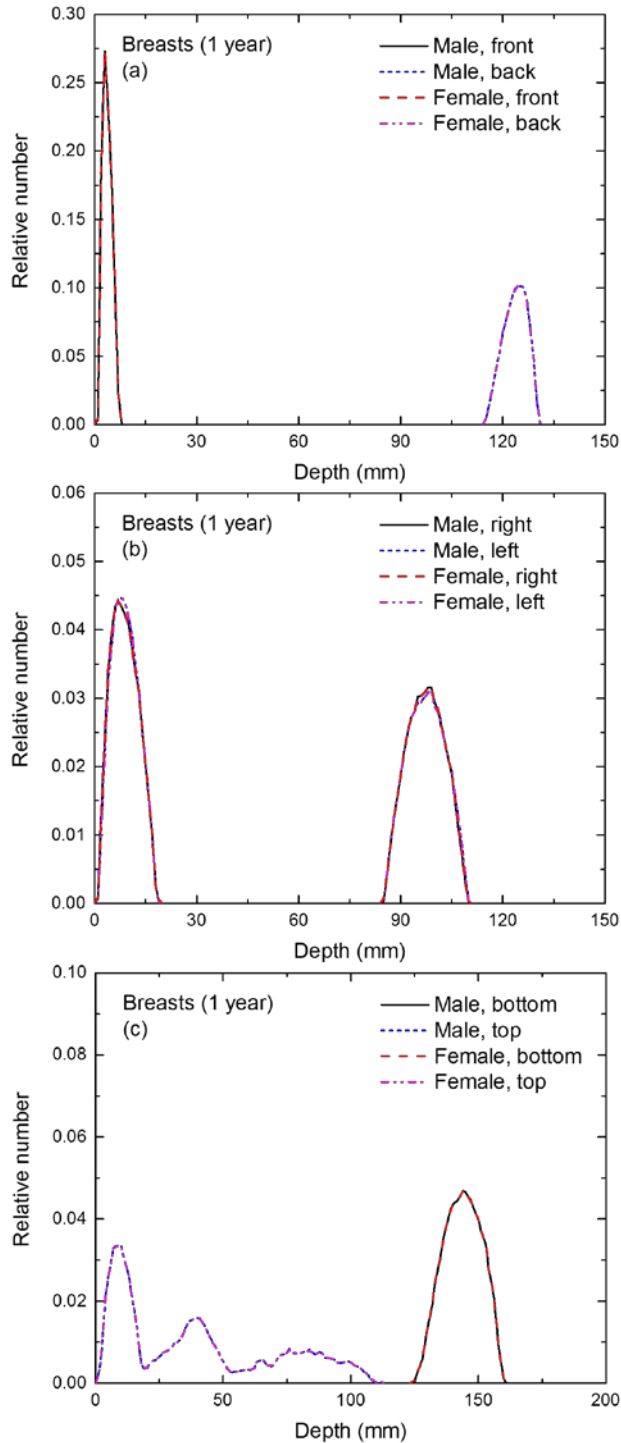
1101

1102 Fig. E.16. Distribution of depths of 10 million randomly sampled points in the *lungs* below the
 1103 body surface of the *1-year-old male/female phantoms* at: (a) front and back, (b) right and left, and
 1104 (c) bottom and top.



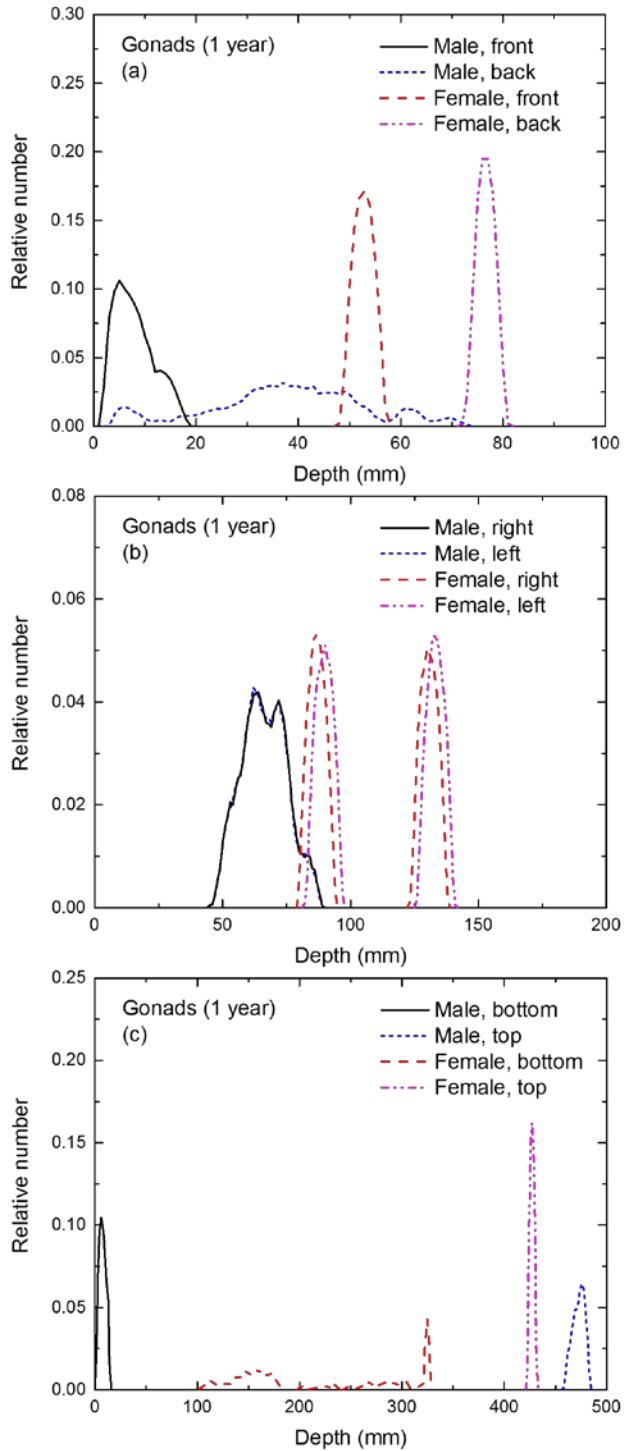
1105

1106 Fig. E.17. Distribution of depths of 10 million randomly sampled points in the *stomach wall* below
 1107 the body surface of the *1-year-old male/female phantoms* at: (a) front and back, (b) right and left,
 1108 and (c) bottom and top.



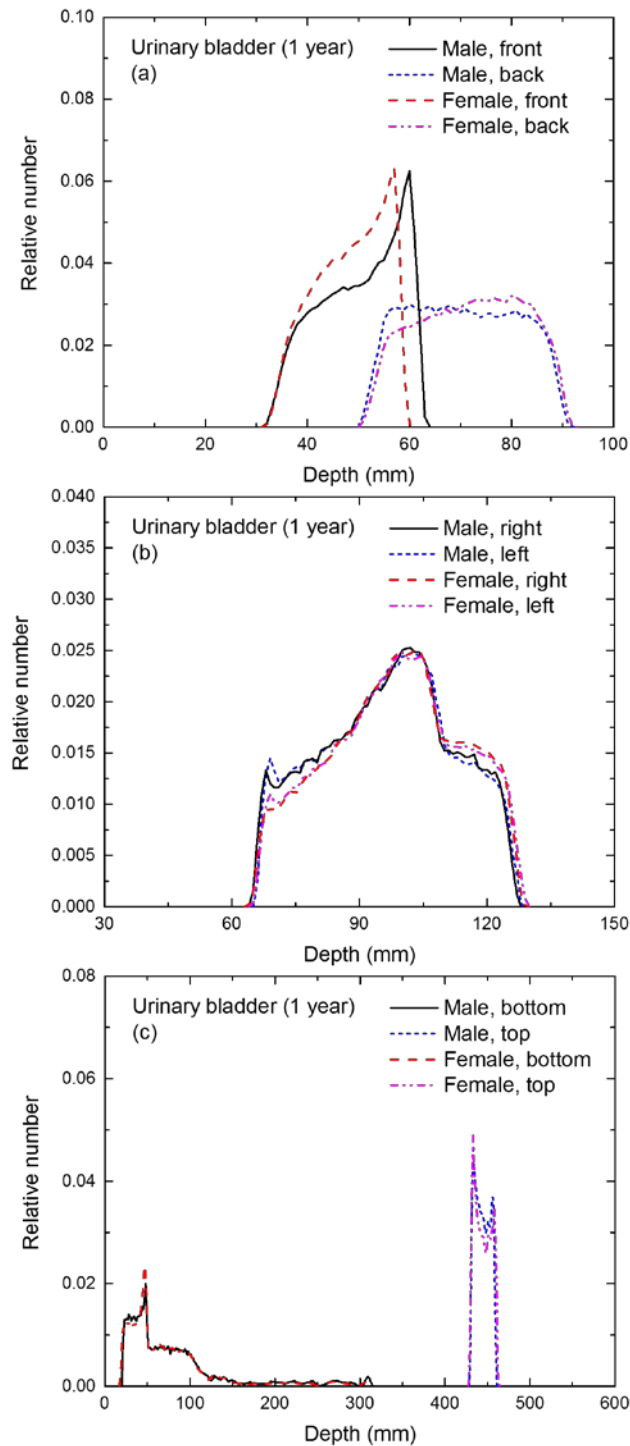
1109

1110 Fig. E.18. Distribution of depths of 10 million randomly sampled points in the *breasts* below the
 1111 body surface of the *1-year-old male/female phantoms* at: (a) front and back, (b) right and left, and
 1112 (c) bottom and top.



1113

1114 Fig. E.19. Distribution of depths of 10 million randomly sampled points in the *gonads* below the
 1115 body surface of the *1-year-old male/female phantoms* at: (a) front and back, (b) right and left, and
 1116 (c) bottom and top.

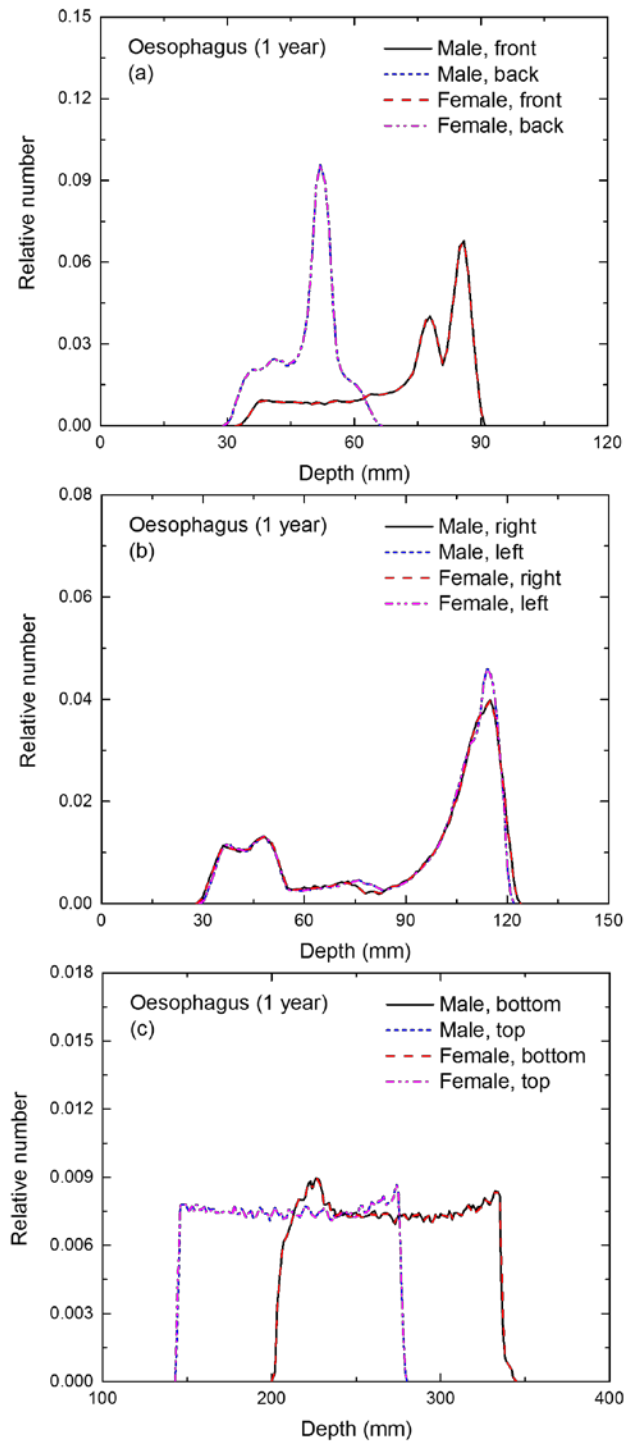


1117

1118 Fig. E.20. Distribution of depths of 10 million randomly sampled points in the *urinary bladder*

1119 *wall* below the body surface of the *1-year-old male/female phantoms* at: (a) front and back, (b)

1120 right and left, and (c) bottom and top.

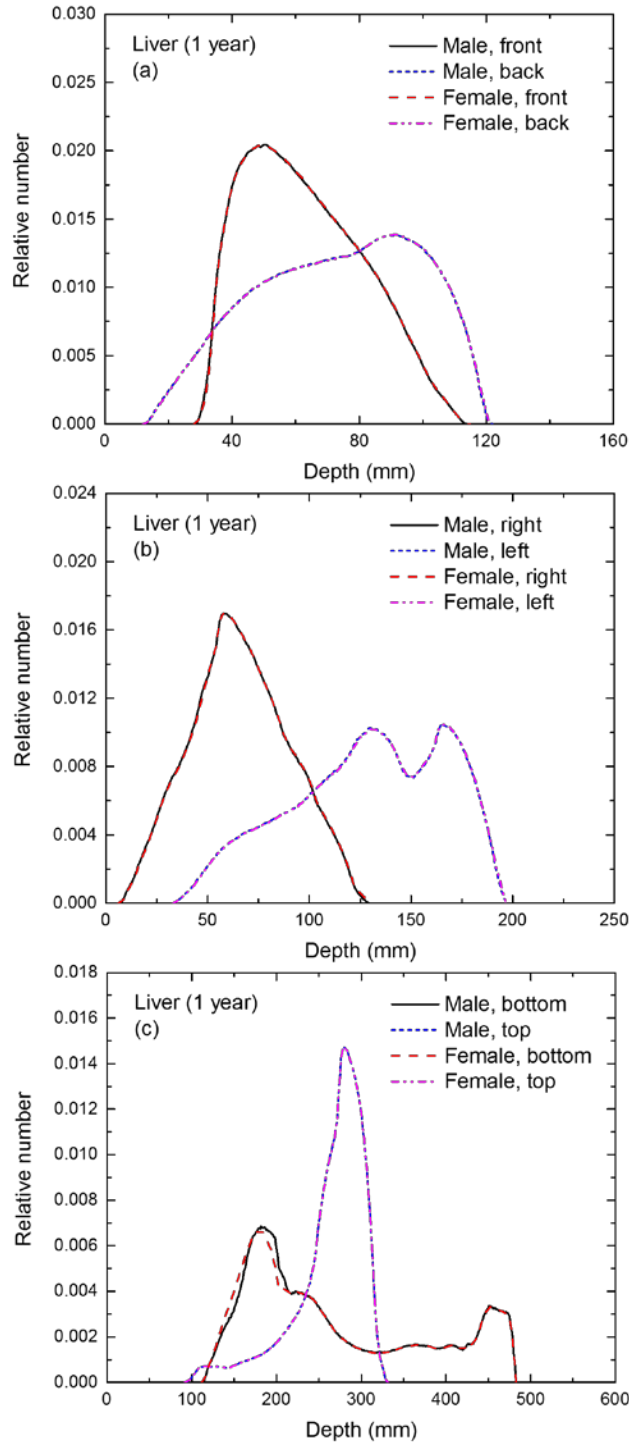


1121

1122 Fig. E.21. Distribution of depths of 10 million randomly sampled points in the *oesophagus wall*

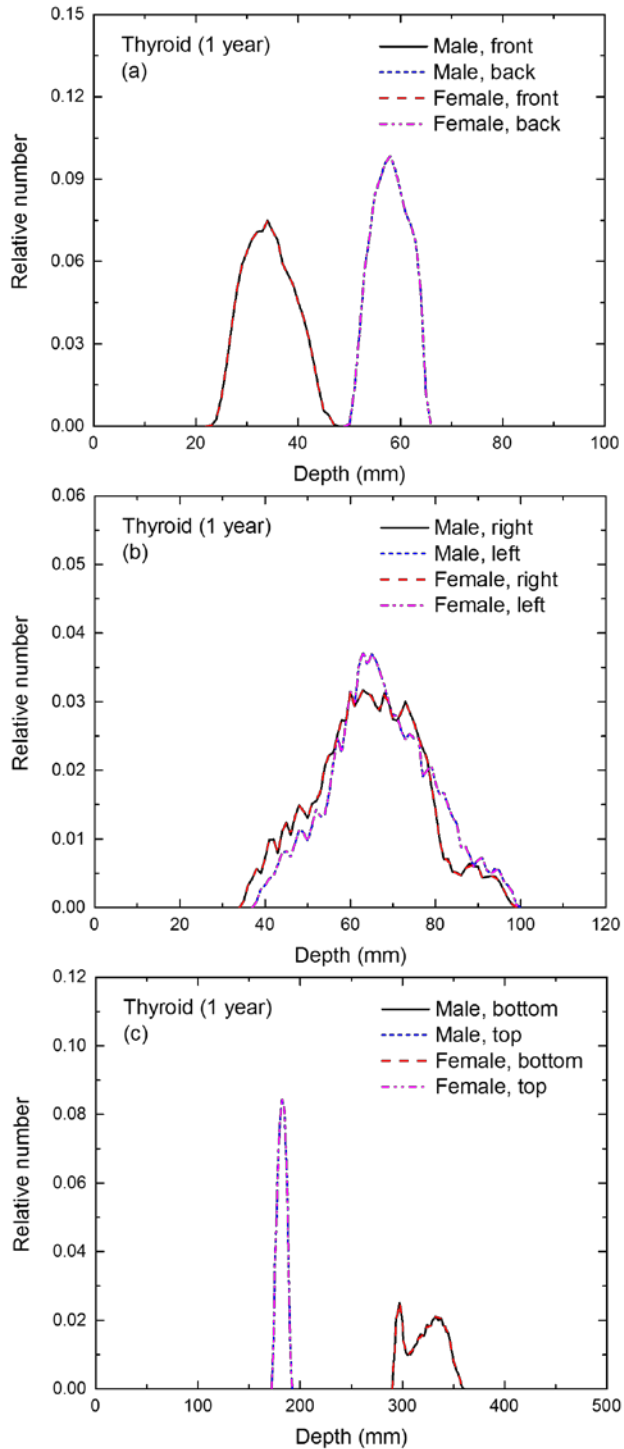
1123 below the body surface of the *1-year-old male/female phantoms* at: (a) front and back, (b) right

1124 and left, and (c) bottom and top.



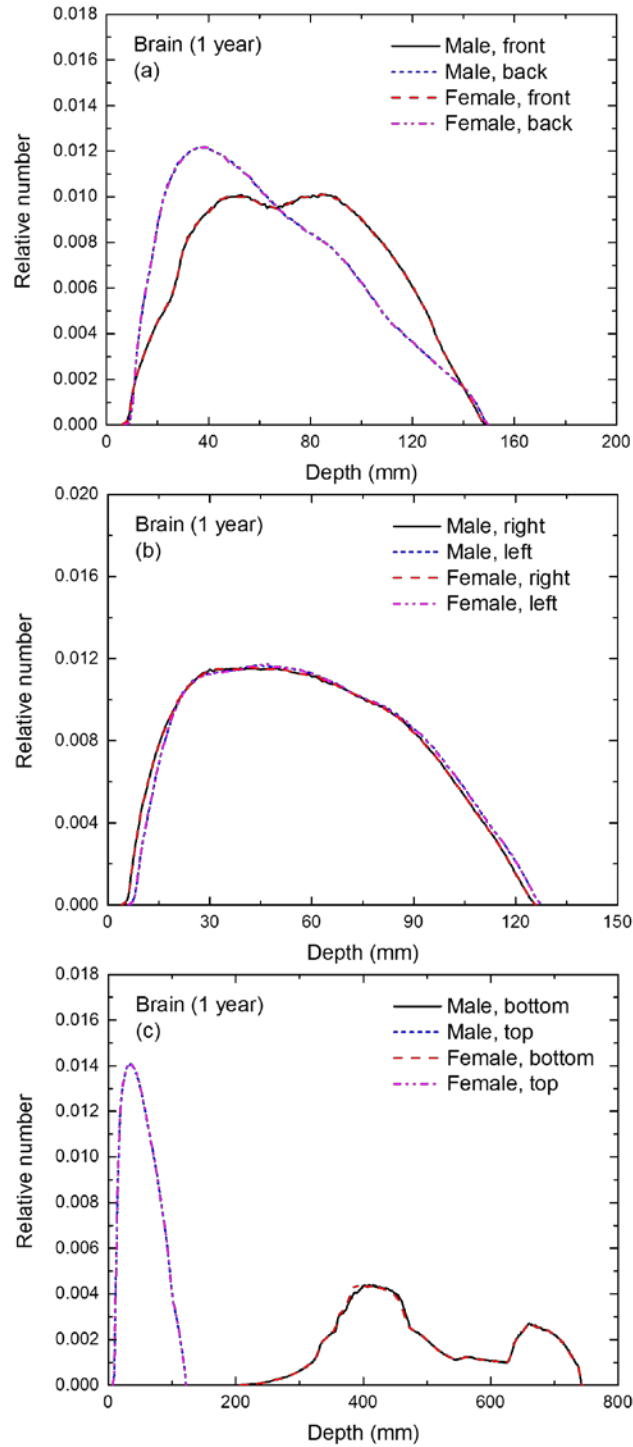
1125

1126 Fig. E.22. Distribution of depths of 10 million randomly sampled points in the *liver* below the
 1127 body surface of the *1-year-old male/female phantoms* at: (a) front and back, (b) right and left, and
 1128 (c) bottom and top.



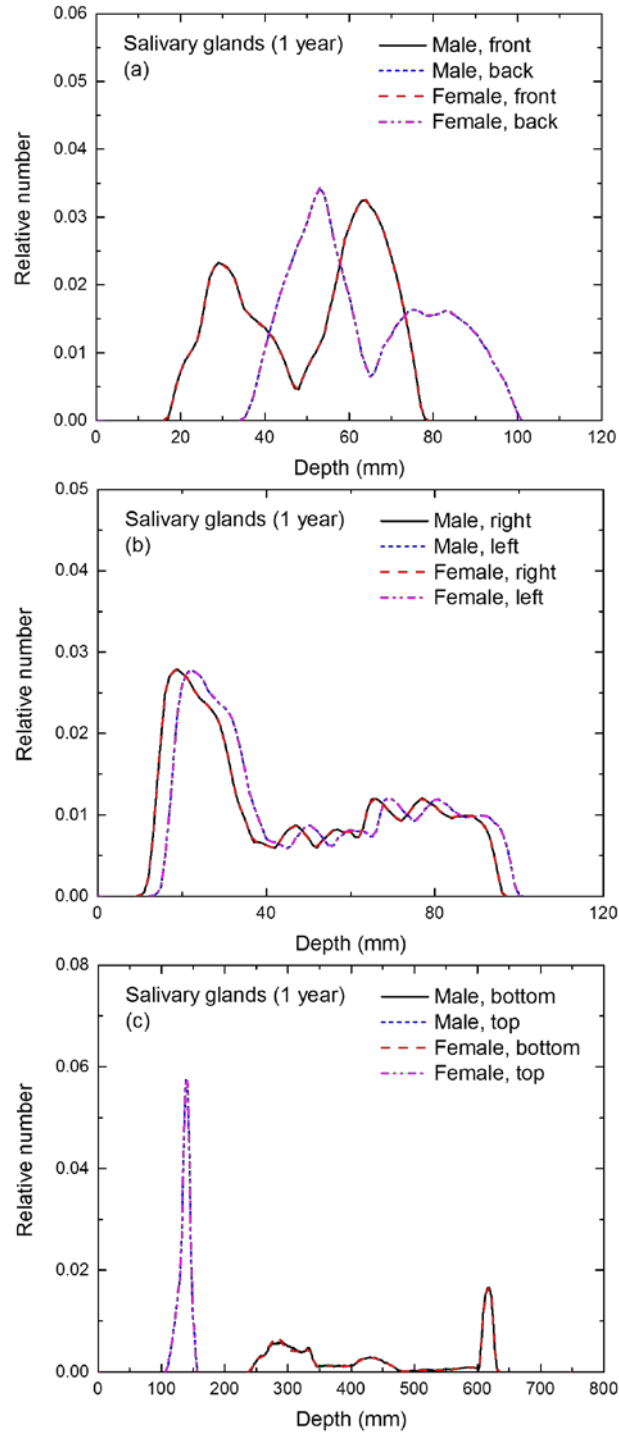
1129

1130 Fig. E.23. Distribution of depths of 10 million randomly sampled points in the *thyroid* below the
 1131 body surface of the *1-year-old male/female phantoms* at: (a) front and back, (b) right and left, and
 1132 (c) bottom and top.



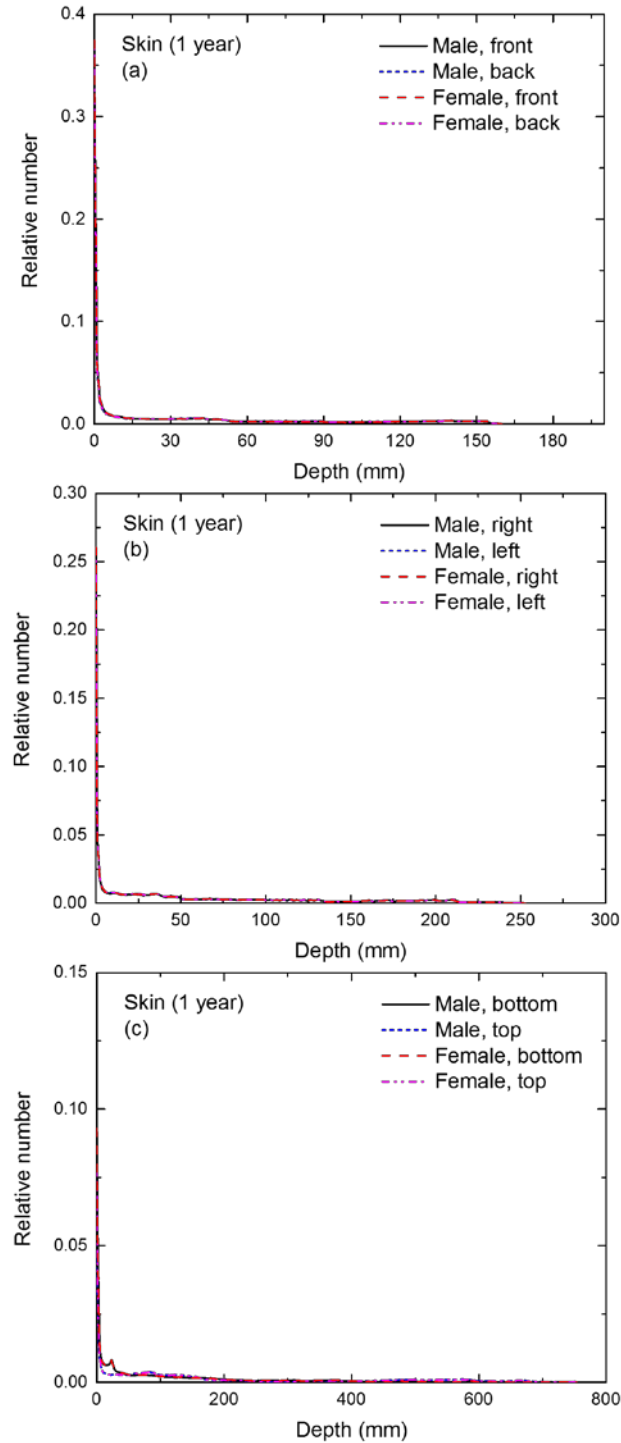
1133

1134 Fig. E.24. Distribution of depths of 10 million randomly sampled points in the *brain* below the
 1135 body surface of the *1-year-old male/female phantoms* at: (a) front and back, (b) right and left, and
 1136 (c) bottom and top.



1137

1138 Fig. E.25. Distribution of depths of 10 million randomly sampled points in the *salivary glands*
 1139 below the body surface of the *1-year-old male/female phantoms* at: (a) front and back, (b) right
 1140 and left, and (c) bottom and top.

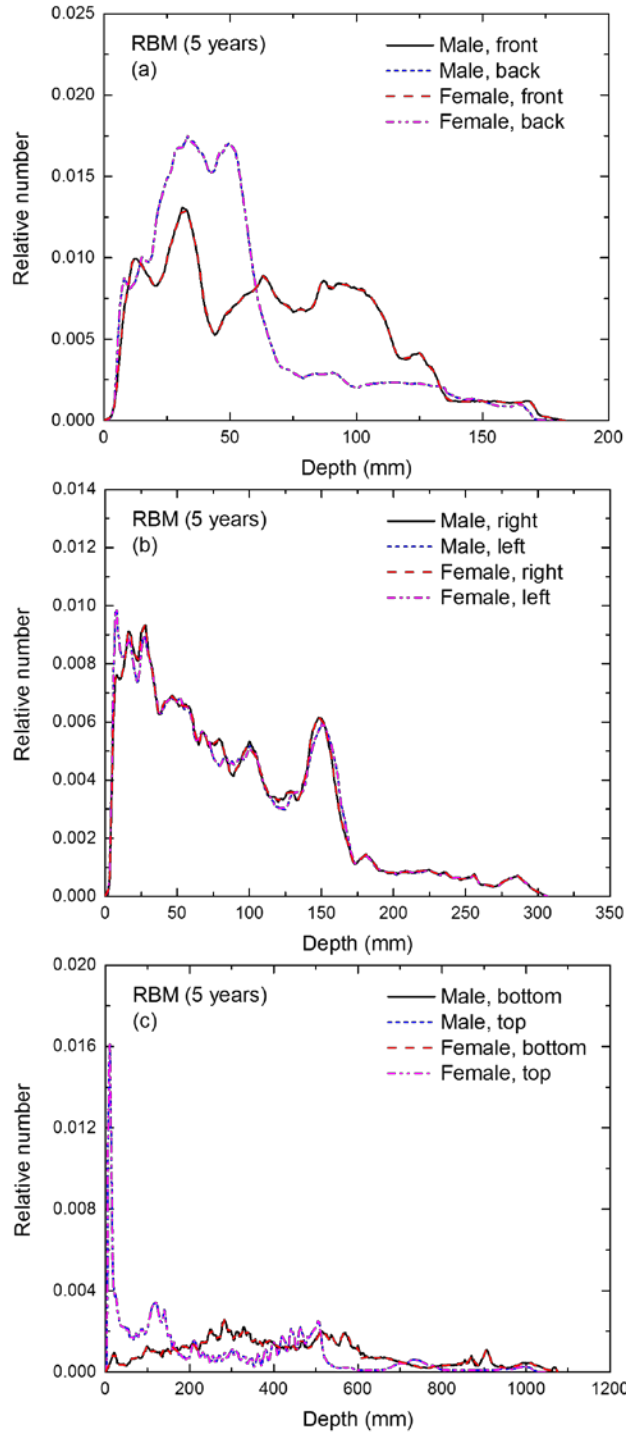


1141

1142 Fig. E.26. Distribution of depths of 10 million randomly sampled points in the *skin* below the body
 1143 surface of the *1-year-old male/female phantoms* at: (a) front and back, (b) right and left, and (c)

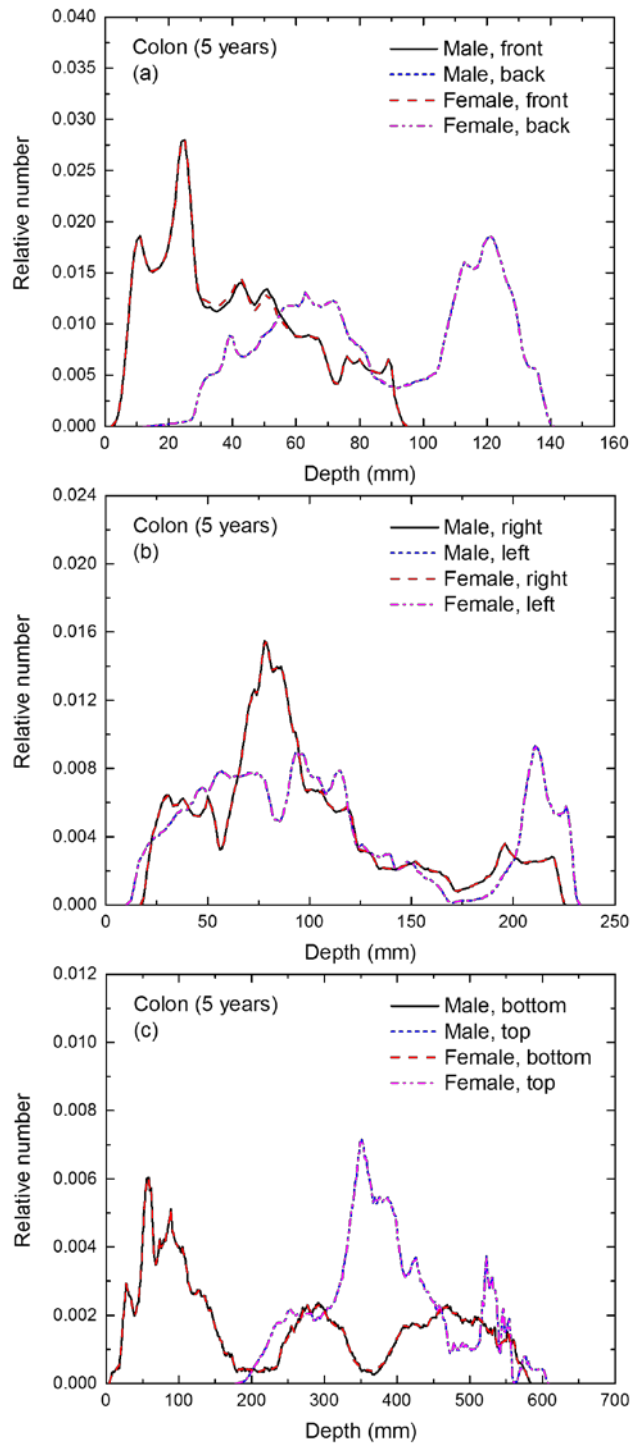
1144 bottom and top.

1145



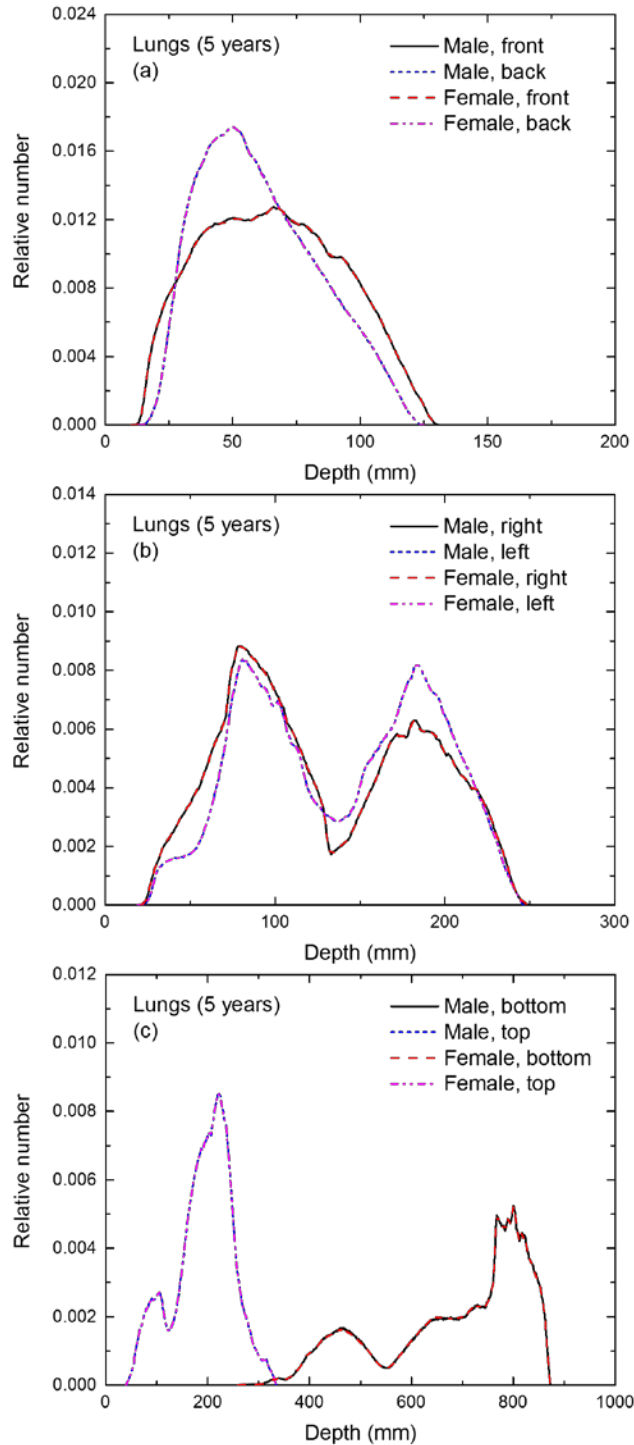
1146

1147 Fig. E.27. Distribution of depths of 10 million randomly sampled points in the *red bone marrow*
 1148 below the body surface of the *5-year-old male/female phantoms* at: (a) front and back, (b) right
 1149 and left, and (c) bottom and top.



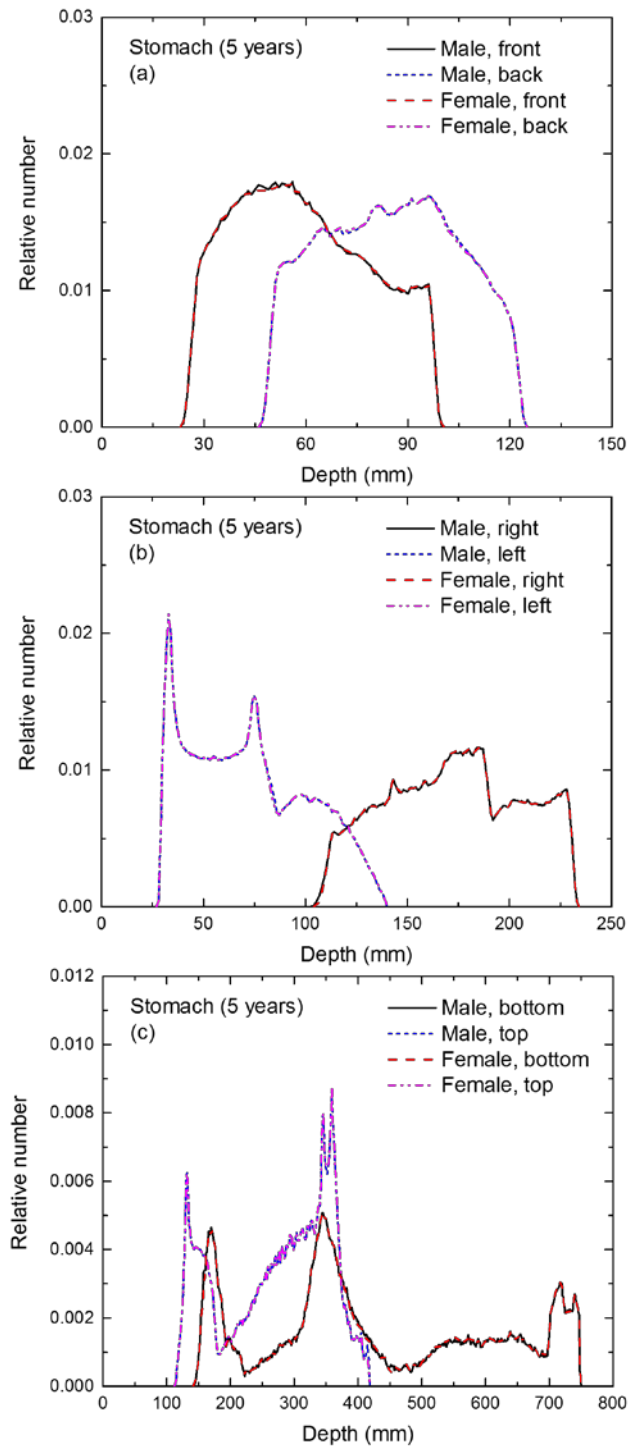
1150

1151 Fig. E.28. Distribution of depths of 10 million randomly sampled points in the *colon wall* below
 1152 the body surface of the *5-year-old male/female phantoms* at: (a) front and back, (b) right and left,
 1153 and (c) bottom and top.



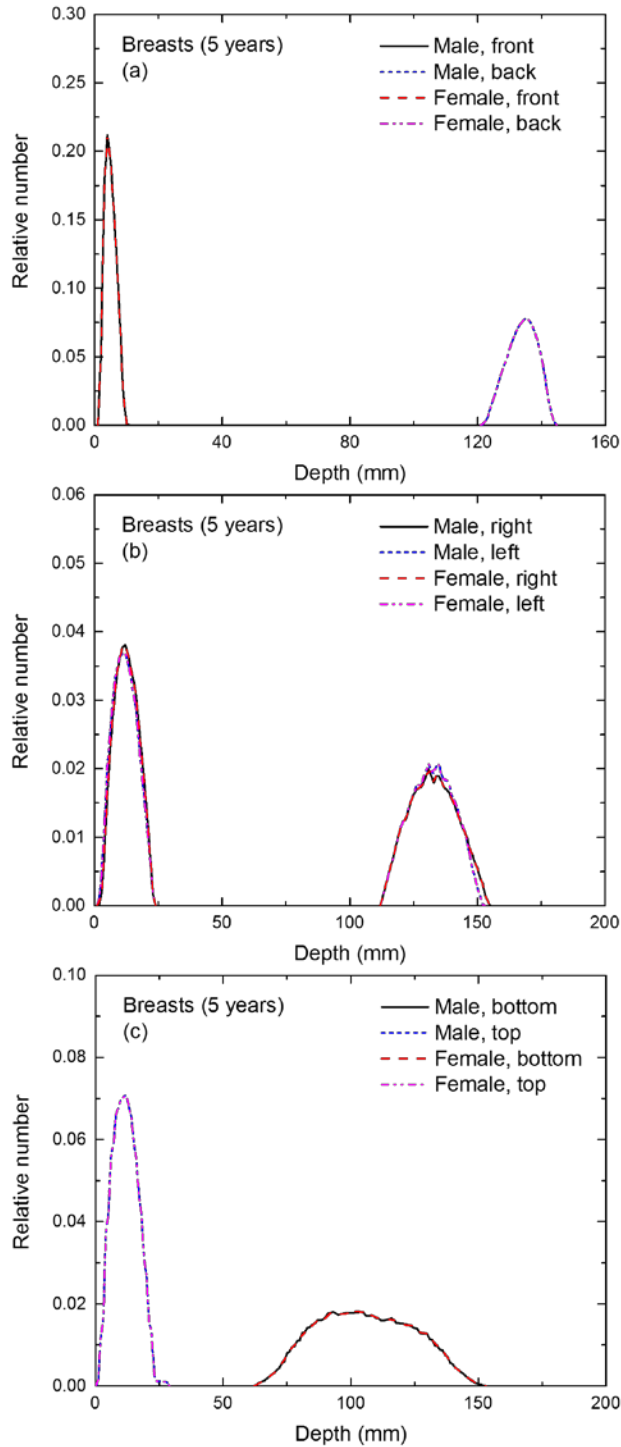
1154

1155 Fig. E.29. Distribution of depths of 10 million randomly sampled points in the *lungs* below the
 1156 body surface of the *5-year-old male/female phantoms* at: (a) front and back, (b) right and left, and
 1157 (c) bottom and top.



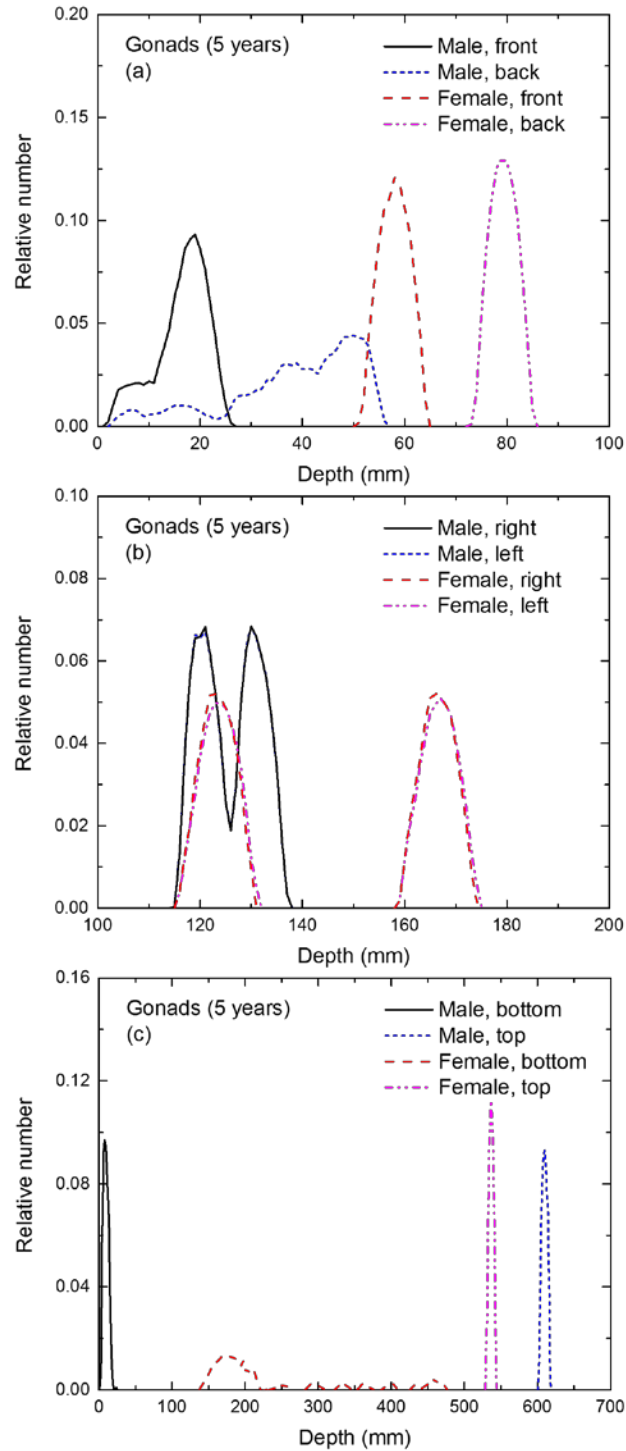
1158

1159 Fig. E.30. Distribution of depths of 10 million randomly sampled points in the *stomach wall* below
 1160 the body surface of the *5-year-old male/female phantoms* at: (a) front and back, (b) right and left,
 1161 and (c) bottom and top.



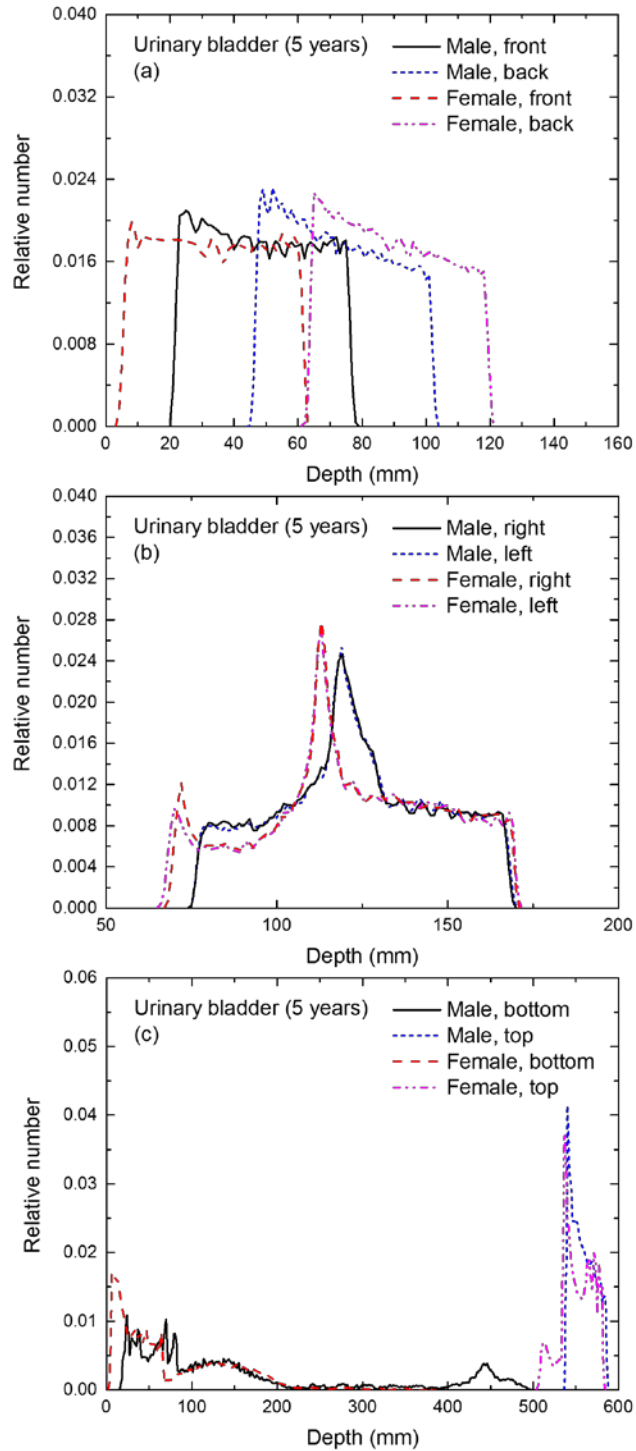
1162

1163 Fig. E.31. Distribution of depths of 10 million randomly sampled points in the *breasts* below the
 1164 body surface of the *5-year-old male/female phantoms* at: (a) front and back, (b) right and left, and
 1165 (c) bottom and top.



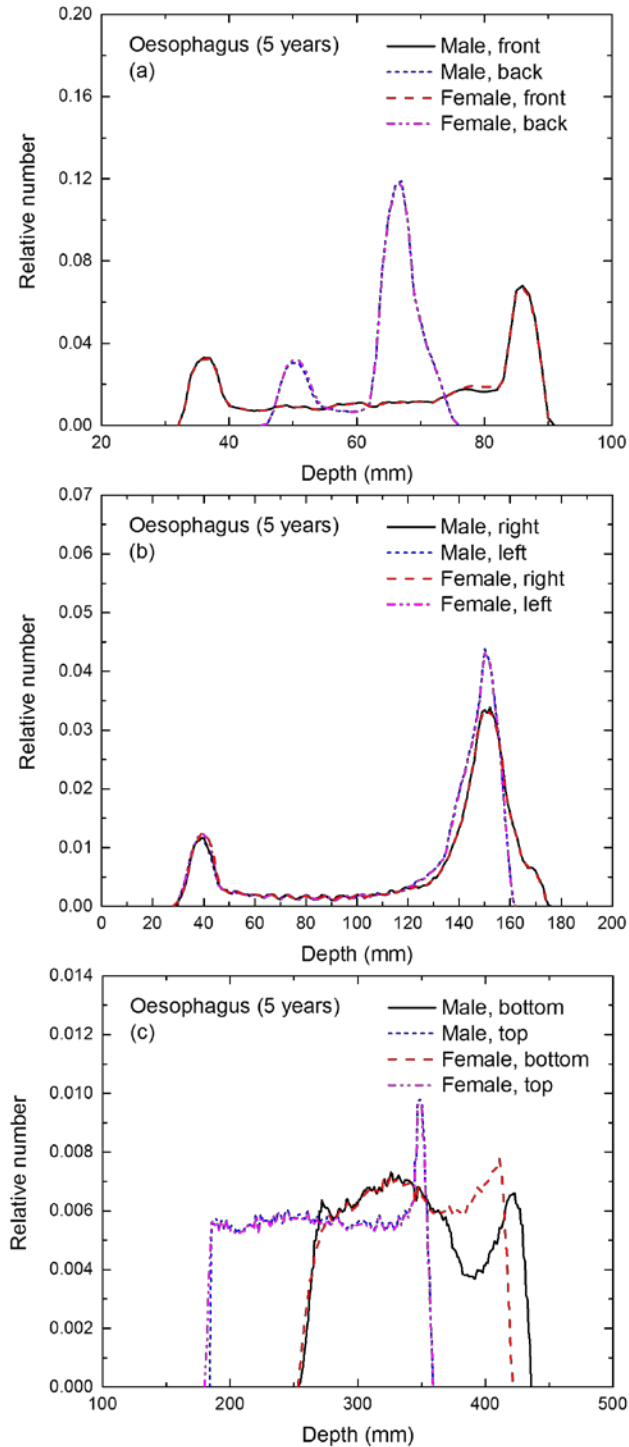
1166

1167 Fig. E.32. Distribution of depths of 10 million randomly sampled points in the *gonads* below the
 1168 body surface of the *5-year-old male/female phantoms* at: (a) front and back, (b) right and left, and
 1169 (c) bottom and top.



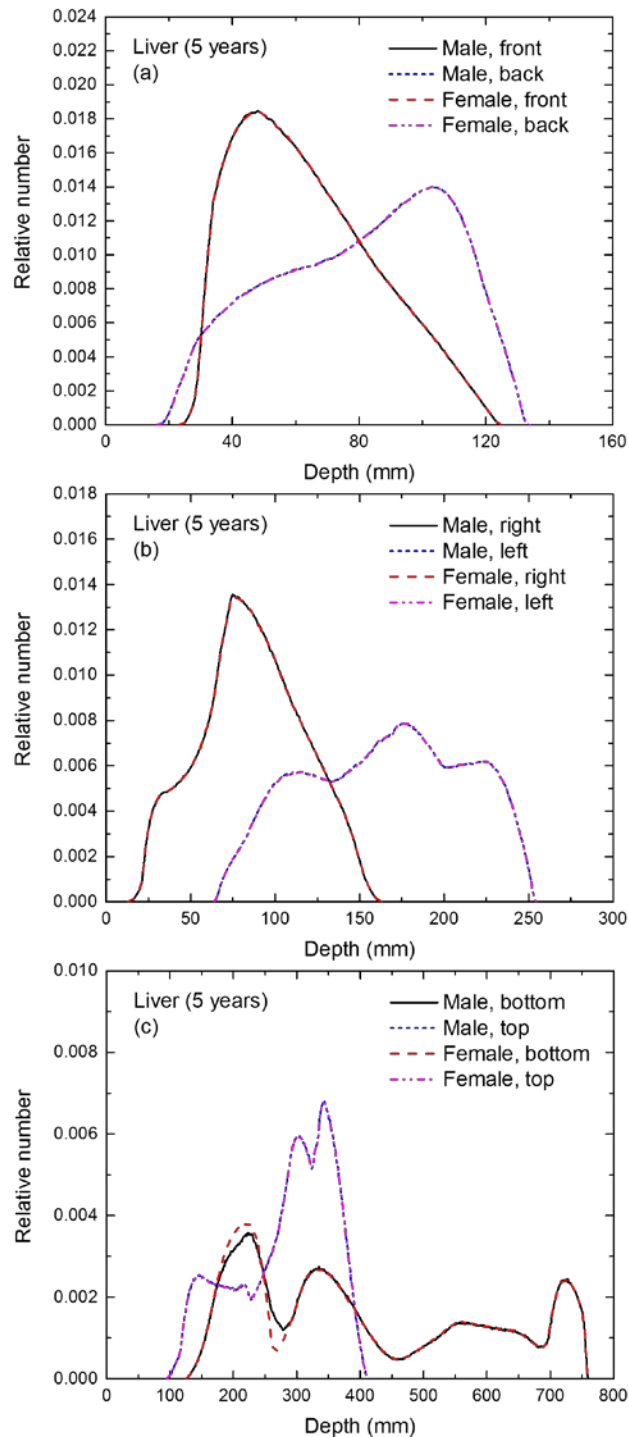
1170

1171 Fig. E.33. Distribution of depths of 10 million randomly sampled points in the *urinary bladder*
 1172 *wall* below the body surface of the *5-year-old male/female phantoms* at: (a) front and back, (b)
 1173 right and left, and (c) bottom and top.



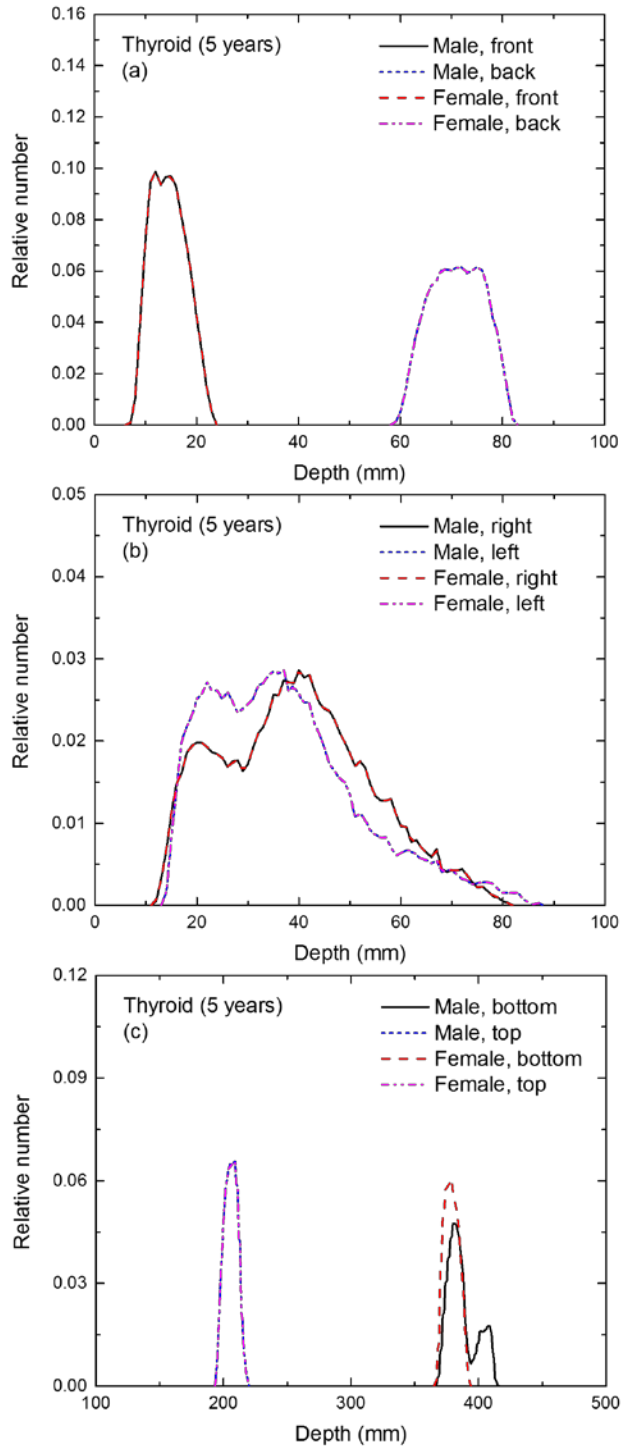
1174

1175 Fig. E.34. Distribution of depths of 10 million randomly sampled points in the *oesophagus wall*
 1176 below the body surface of the *5-year-old male/female phantoms* at: (a) front and back, (b) right
 1177 and left, and (c) bottom and top.



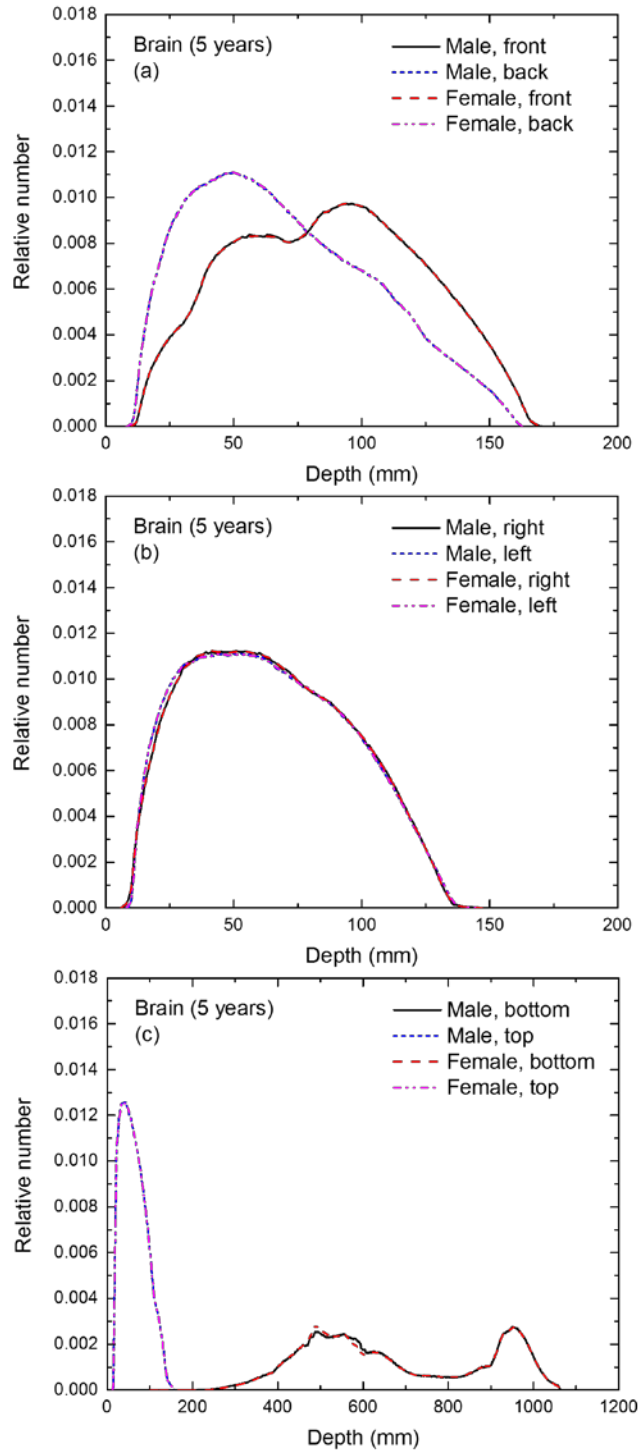
1178

1179 Fig. E.35. Distribution of depths of 10 million randomly sampled points in the *liver* below the
 1180 body surface of the *5-year-old male/female phantoms* at: (a) front and back, (b) right and left, and
 1181 (c) bottom and top.



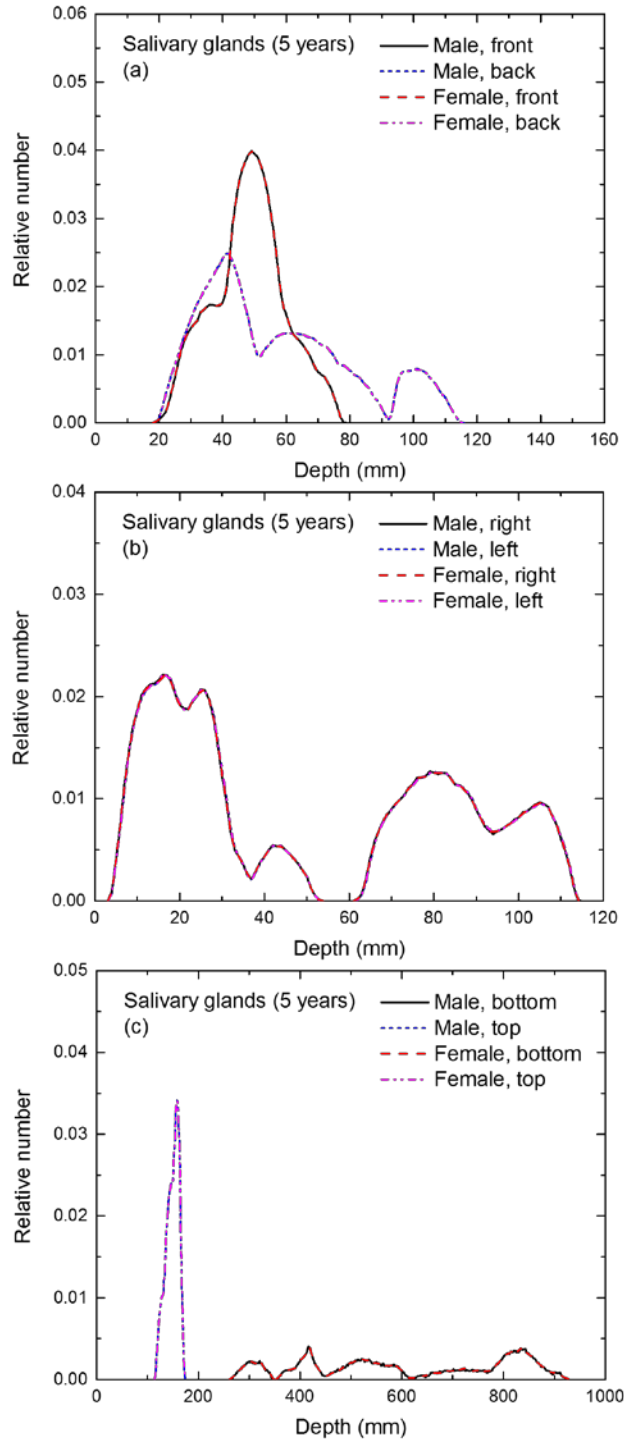
1182

1183 Fig. E.36. Distribution of depths of 10 million randomly sampled points in the *thyroid* below the
 1184 body surface of the *5-year-old male/female phantoms* at: (a) front and back, (b) right and left, and
 1185 (c) bottom and top.



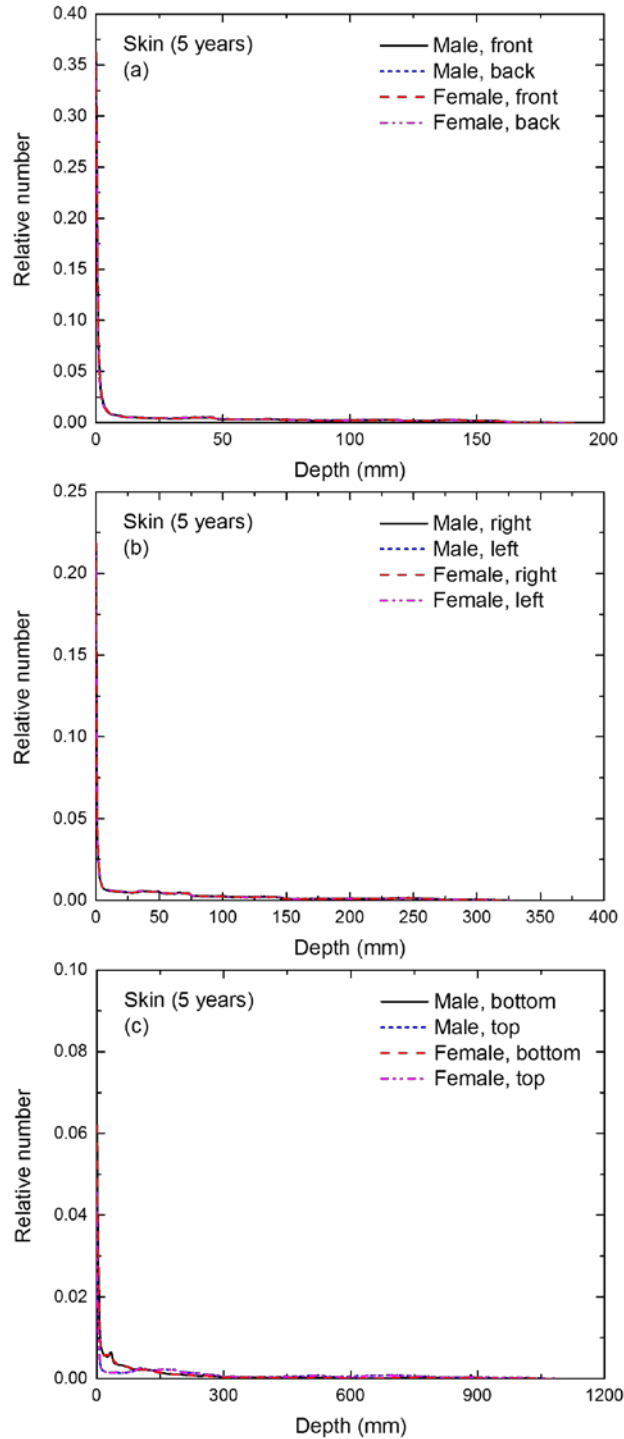
1186

1187 Fig. E.37. Distribution of depths of 10 million randomly sampled points in the *brain* below the
 1188 body surface of the *5-year-old male/female phantoms* at: (a) front and back, (b) right and left, and
 1189 (c) bottom and top.



1190

1191 Fig. E.38. Distribution of depths of 10 million randomly sampled points in the *salivary glands*
 1192 below the body surface of the *5-year-old male/female phantoms* at: (a) front and back, (b) right
 1193 and left, and (c) bottom and top.



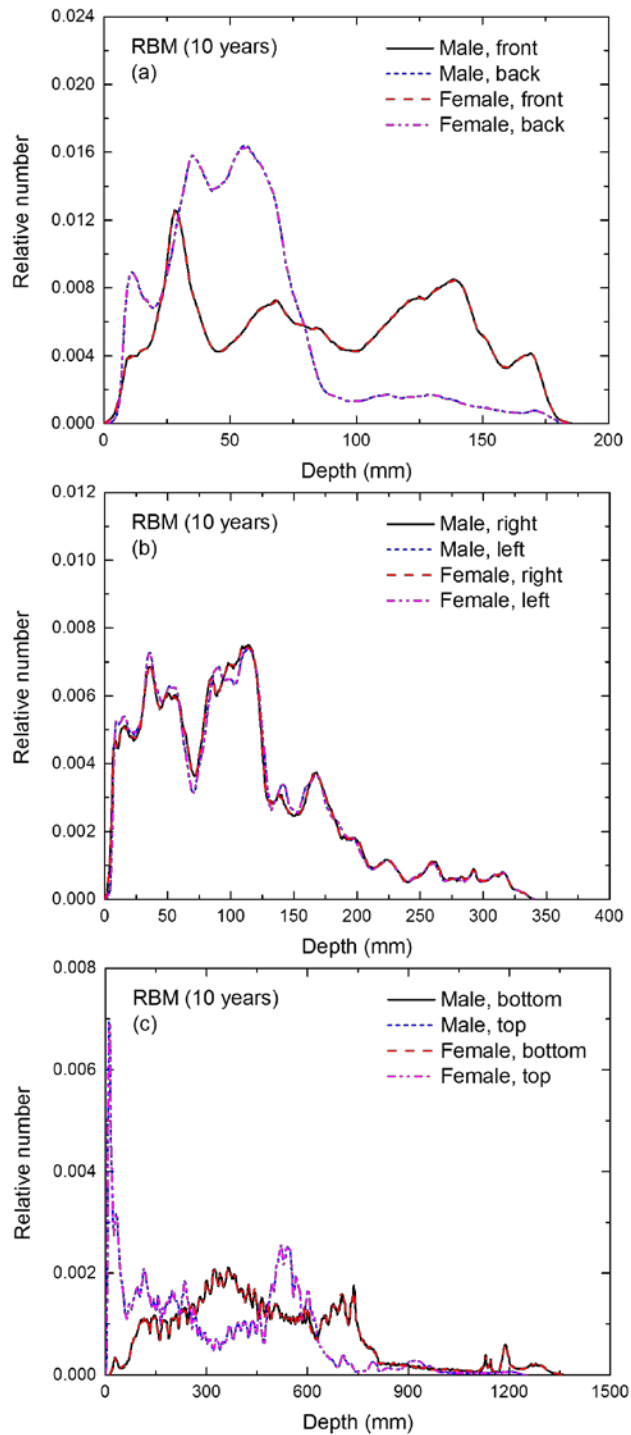
1194

1195 Fig. E.39. Distribution of depths of 10 million randomly sampled points in the *skin* below the body

1196 surface of the *5-year-old male/female phantoms* at: (a) front and back, (b) right and left, and (c)

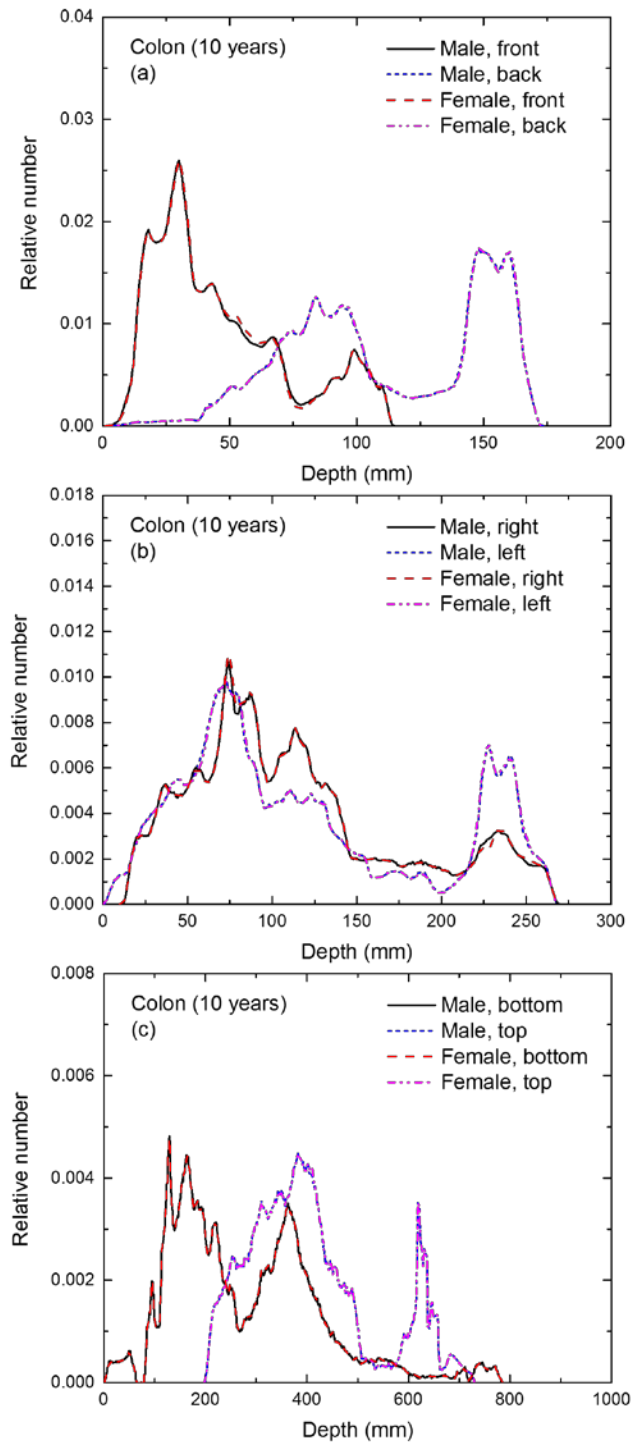
1197 bottom and top.

1198



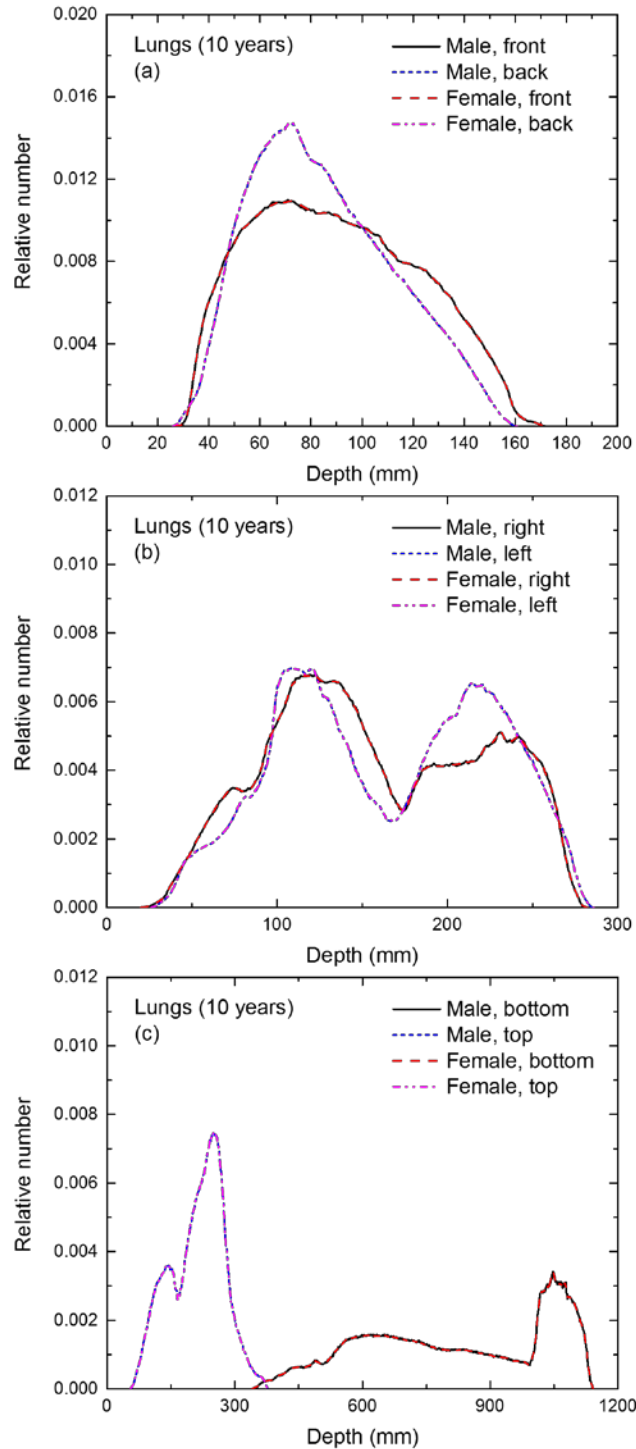
1199

1200 Fig. E.40. Distribution of depths of 10 million randomly sampled points in the *red bone marrow*
 1201 below the body surface of the *10-year-old male/female phantoms* at: (a) front and back, (b) right
 1202 and left, and (c) bottom and top.



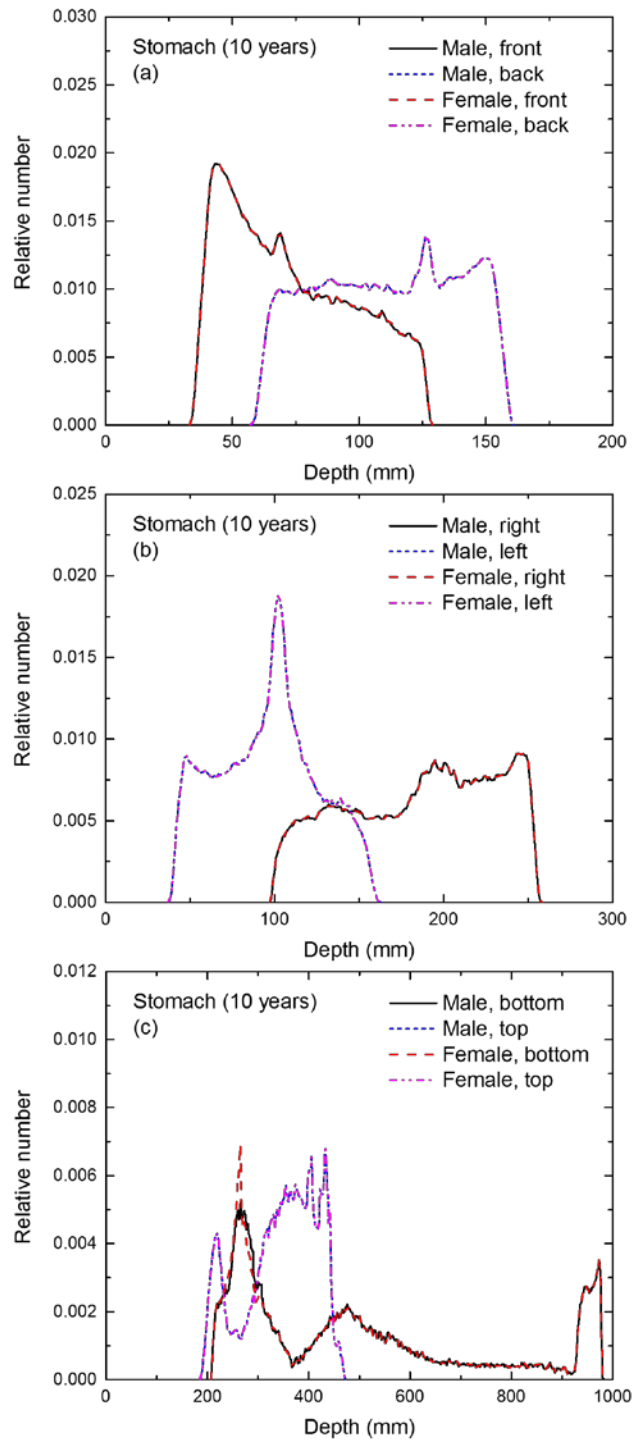
1203

1204 Fig. E.41. Distribution of depths of 10 million randomly sampled points in the *colon wall* below
 1205 the body surface of the *10-year-old male/female phantoms* at: (a) front and back, (b) right and
 1206 left, and (c) bottom and top.



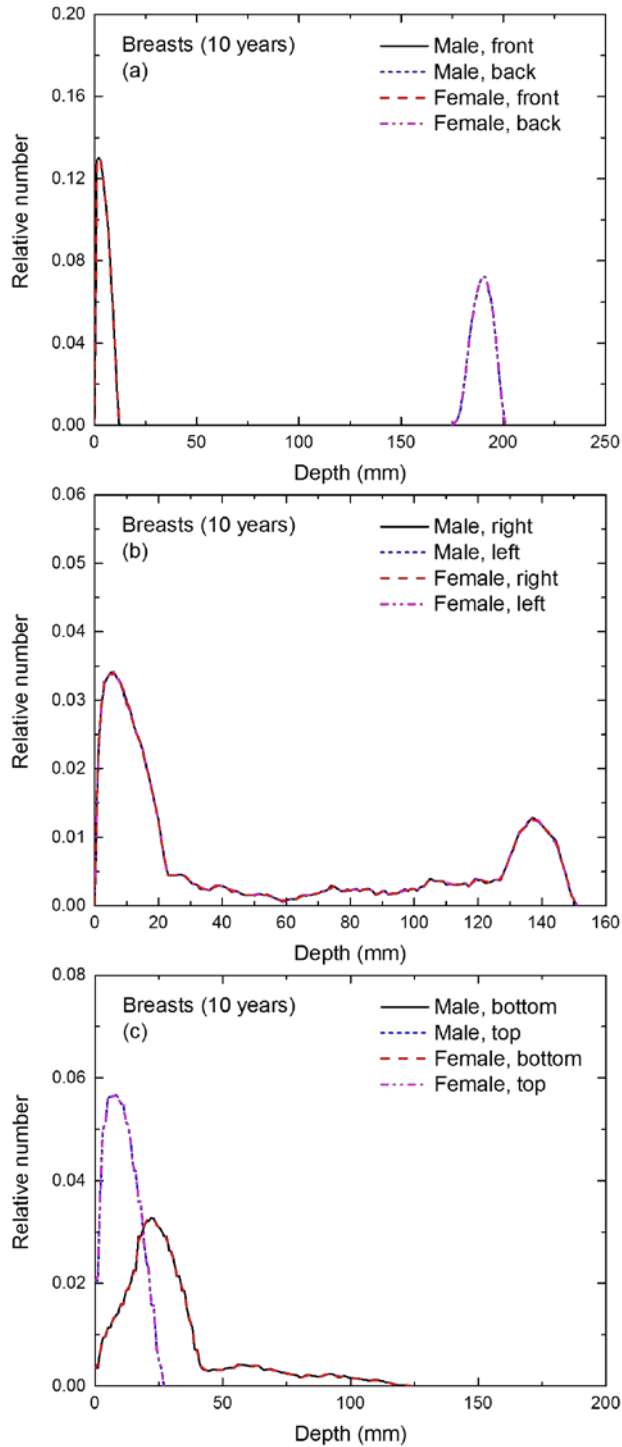
1207

1208 Fig. E.42. Distribution of depths of 10 million randomly sampled points in the *lungs* below the
 1209 body surface of the *10-year-old male/female phantoms* at: (a) front and back, (b) right and left,
 1210 and (c) bottom and top.



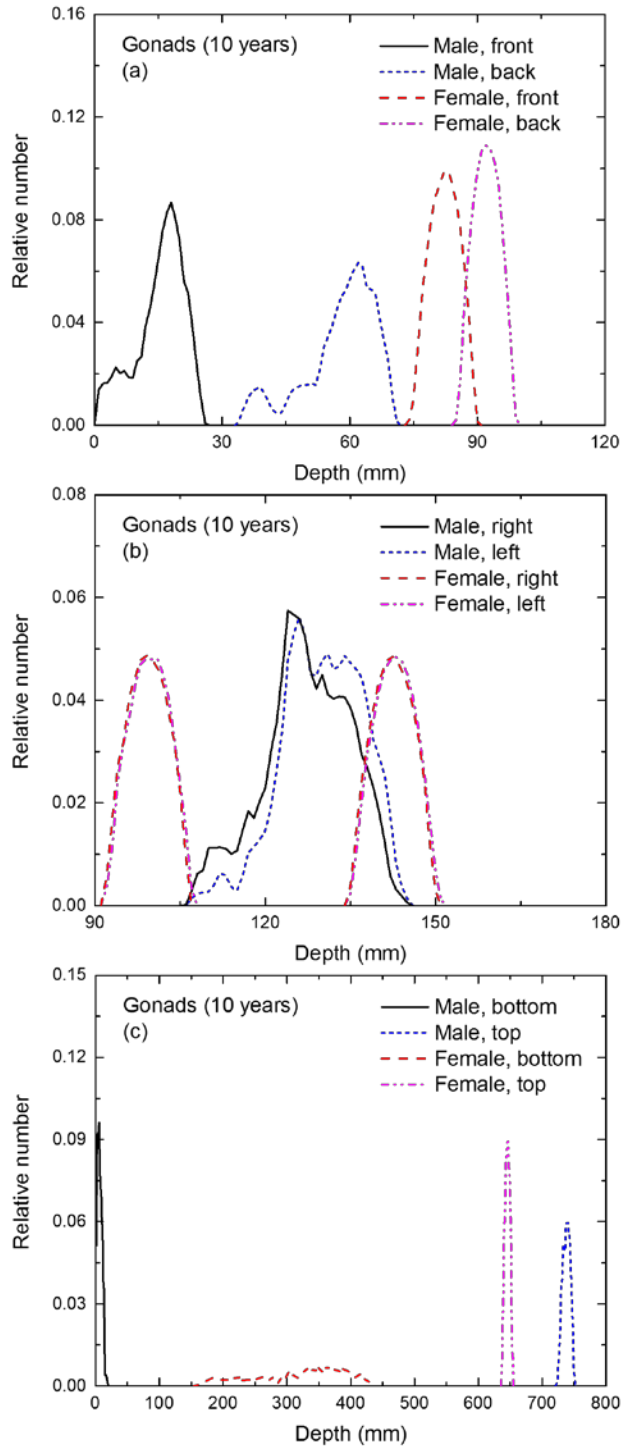
1211

1212 Fig. E.43. Distribution of depths of 10 million randomly sampled points in the *stomach wall* below
 1213 the body surface of the *10-year-old male/female phantoms* at: (a) front and back, (b) right and
 1214 left, and (c) bottom and top.



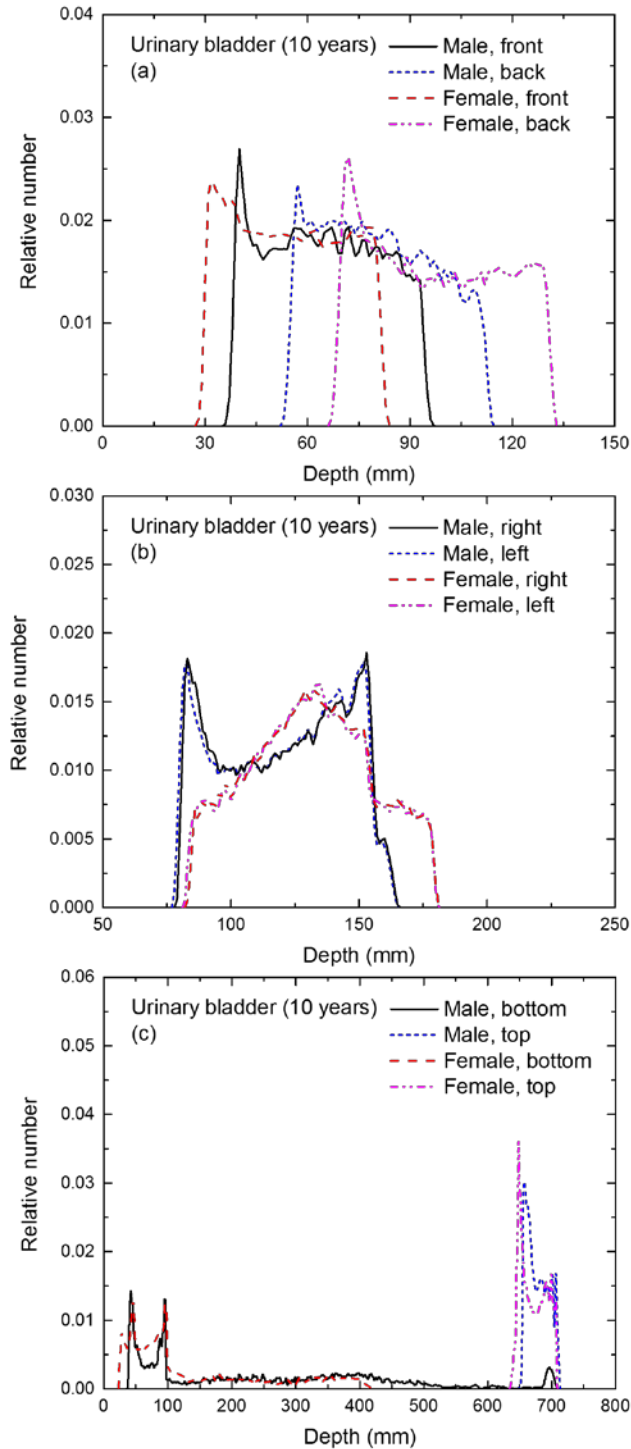
1215

1216 Fig. E.44. Distribution of depths of 10 million randomly sampled points in the *breasts* below the
 1217 body surface of the *10-year-old male/female phantoms* at: (a) front and back, (b) right and left,
 1218 and (c) bottom and top.



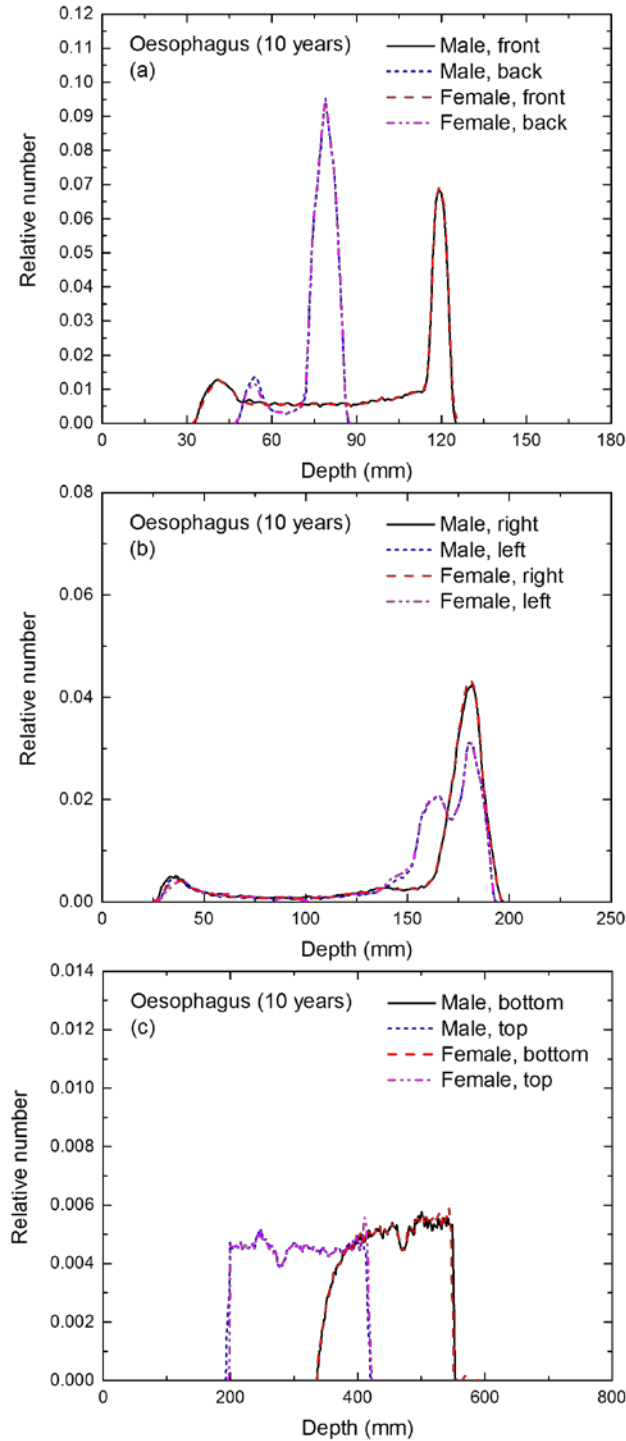
1219

1220 Fig. E.45. Distribution of depths of 10 million randomly sampled points in the *gonads* below the
 1221 body surface of the *10-year-old male/female phantoms* at: (a) front and back, (b) right and left,
 1222 and (c) bottom and top.



1223

1224 Fig. E.46. Distribution of depths of 10 million randomly sampled points in the *urinary bladder*
 1225 *wall* below the body surface of the *10-year-old male/female phantoms* at: (a) front and back, (b)
 1226 right and left, and (c) bottom and top.

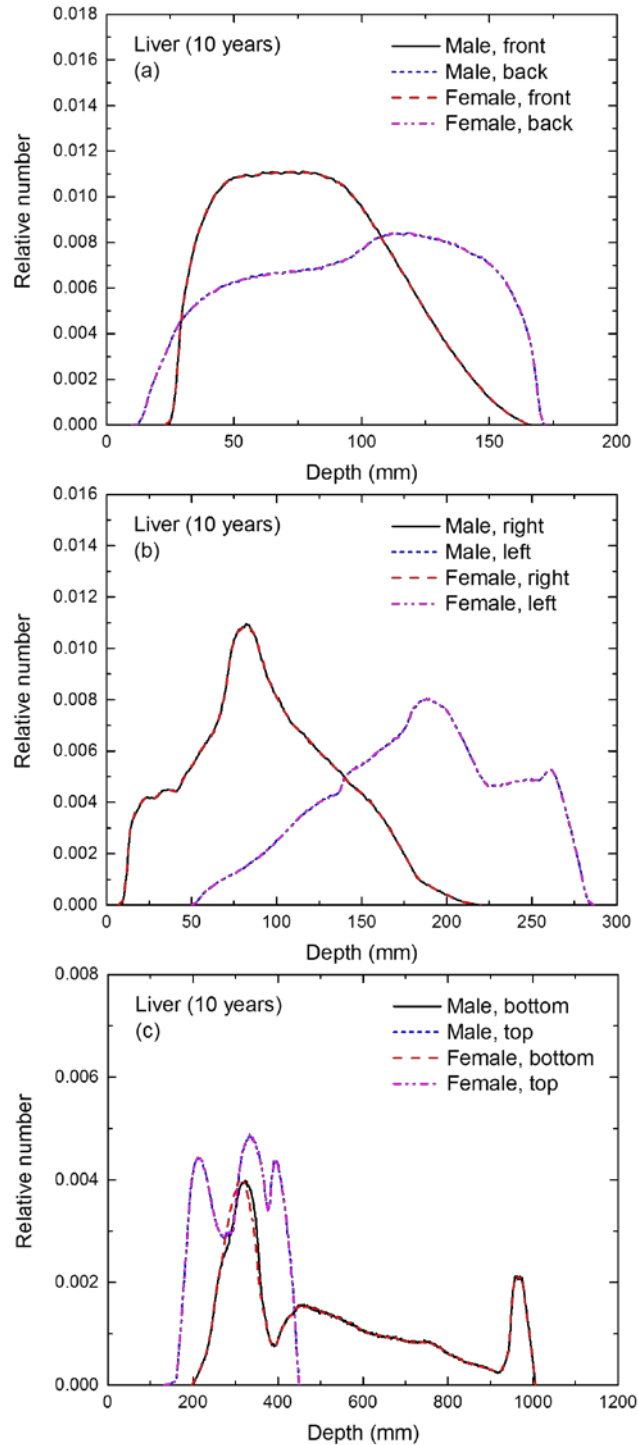


1227

1228 Fig. E.47. Distribution of depths of 10 million randomly sampled points in the *oesophagus wall*

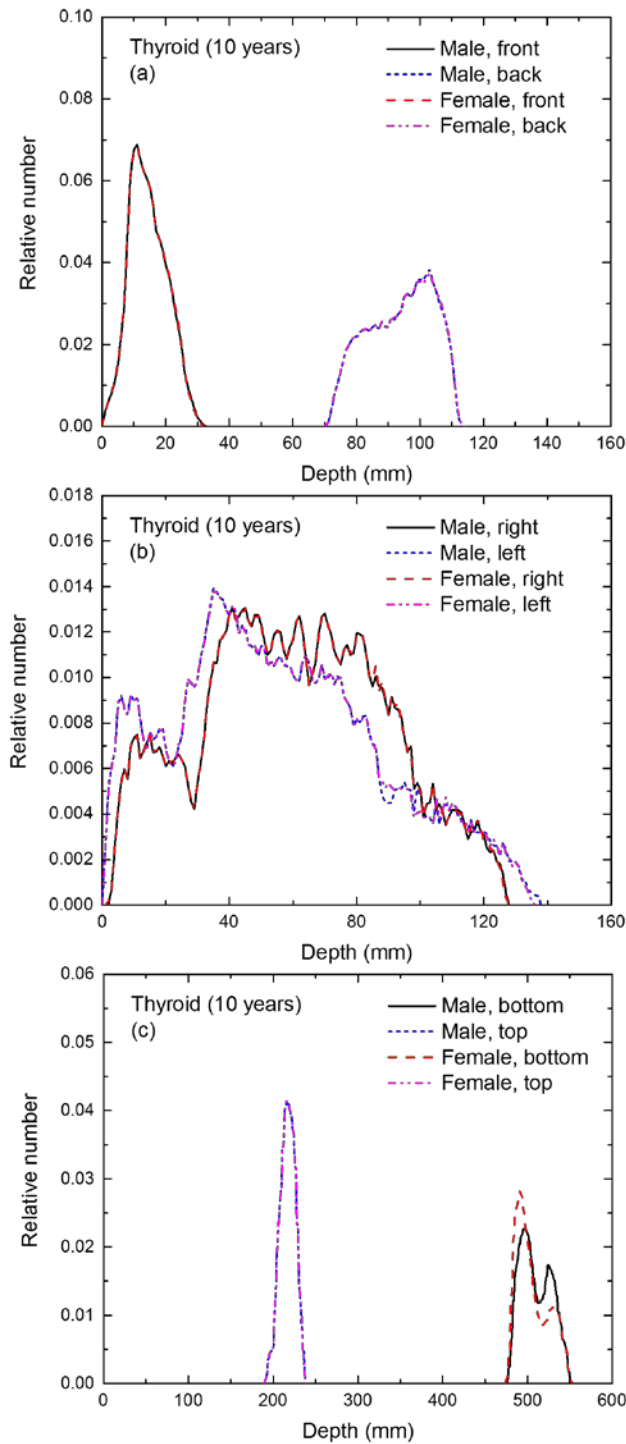
1229 below the body surface of the *10-year-old male/female phantoms* at: (a) front and back, (b) right

1230 and left, and (c) bottom and top.



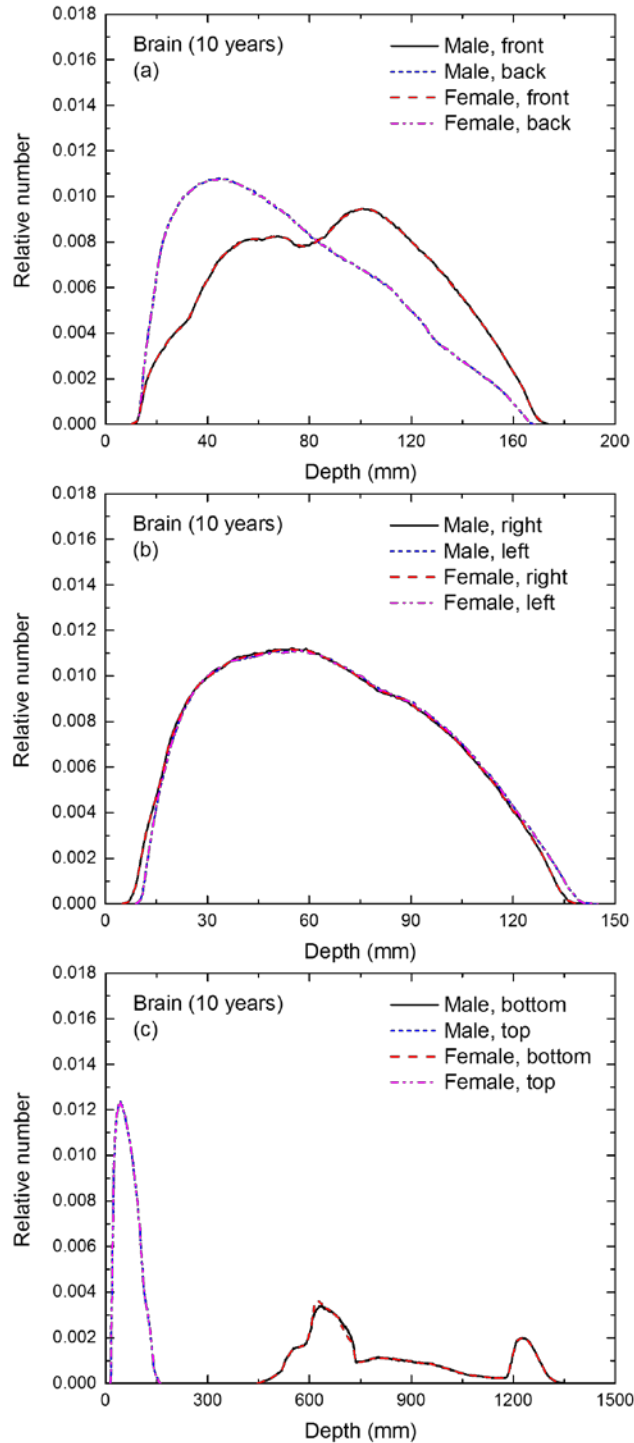
1231

1232 Fig. E.48. Distribution of depths of 10 million randomly sampled points in the *liver* below the
 1233 body surface of the *10-year-old male/female phantoms* at: (a) front and back, (b) right and left,
 1234 and (c) bottom and top.



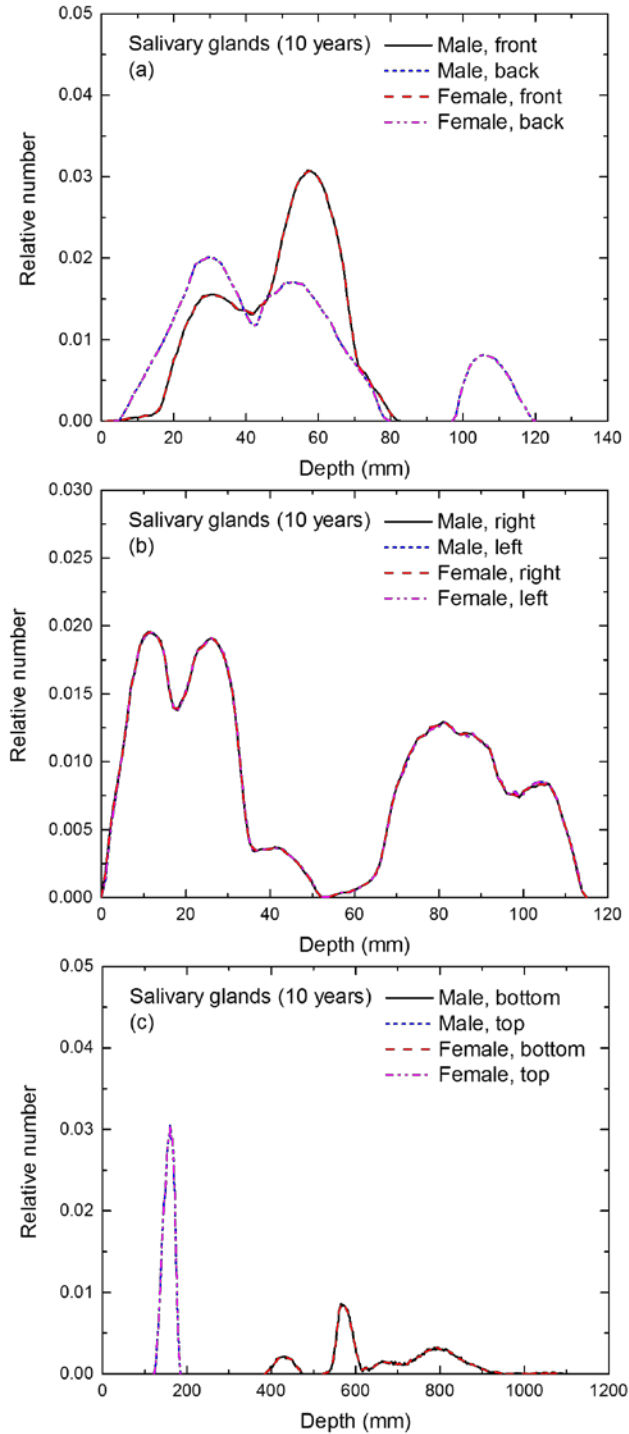
1235

1236 Fig. E.49. Distribution of depths of 10 million randomly sampled points in the *thyroid* below the
 1237 body surface of the *10-year-old male/female phantoms* at: (a) front and back, (b) right and left,
 1238 and (c) bottom and top.



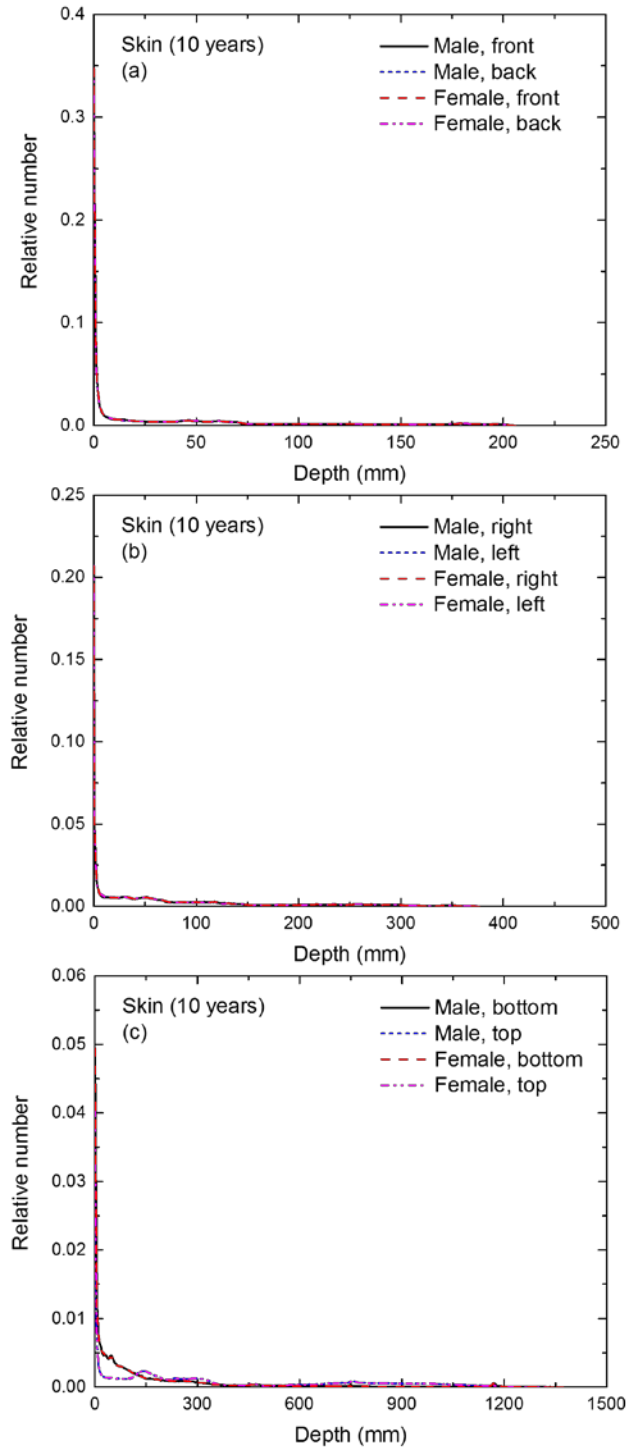
1239

1240 Fig. E.50. Distribution of depths of 10 million randomly sampled points in the *brain* below the
 1241 body surface of the *10-year-old male/female phantoms* at: (a) front and back, (b) right and left,
 1242 and (c) bottom and top.



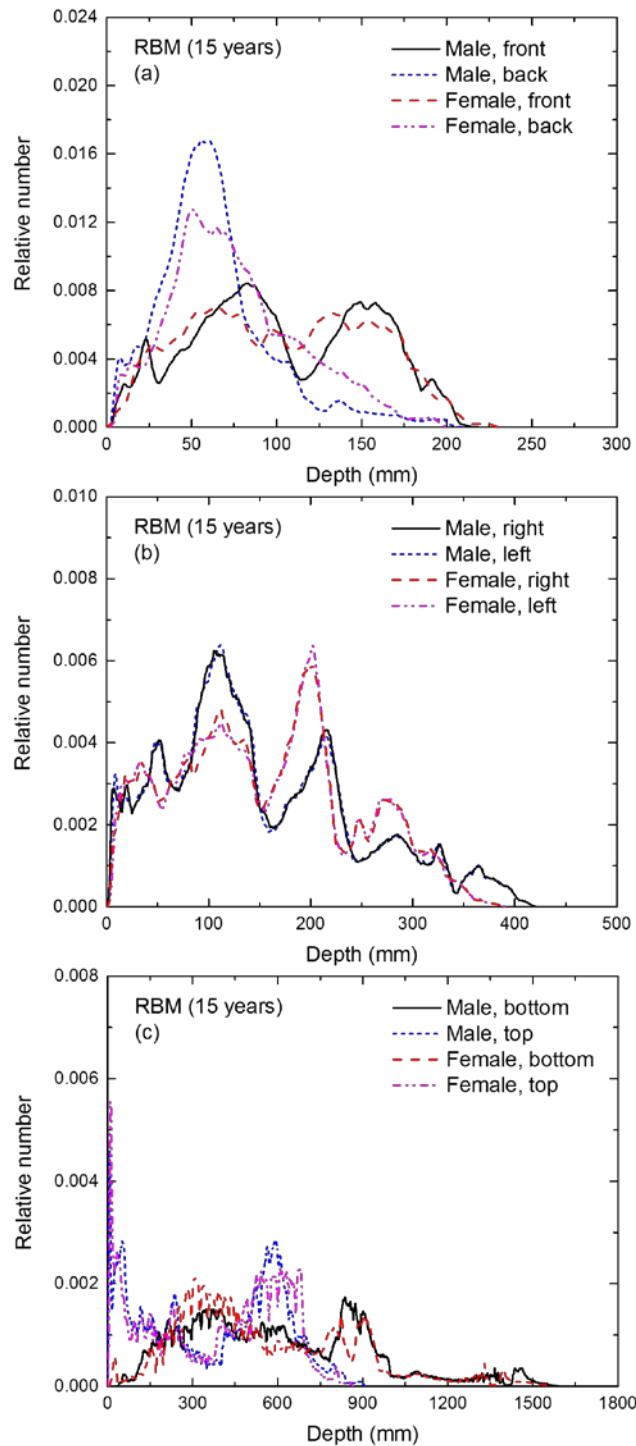
1243

1244 Fig. E.51. Distribution of depths of 10 million randomly sampled points in the *salivary glands*
 1245 below the body surface of the *10-year-old male/female phantoms* at: (a) front and back, (b) right
 1246 and left, and (c) bottom and top.



1247

1248 Fig. E.52. Distribution of depths of 10 million randomly sampled points in the *skin* below the body
 1249 surface of the *10-year-old male/female phantoms* at: (a) front and back, (b) right and left, and (c)
 1250 bottom and top.

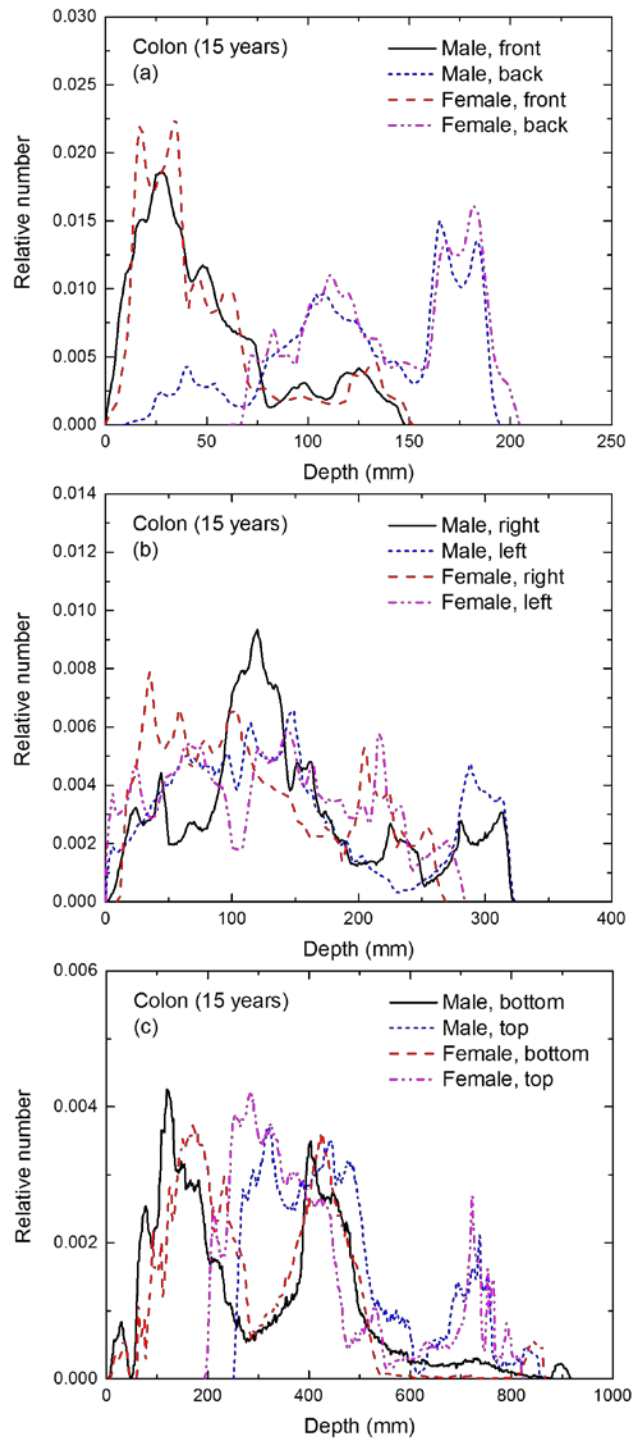


1251

1252 Fig. E.53. Distribution of depths of 10 million randomly sampled points in the *red bone marrow*

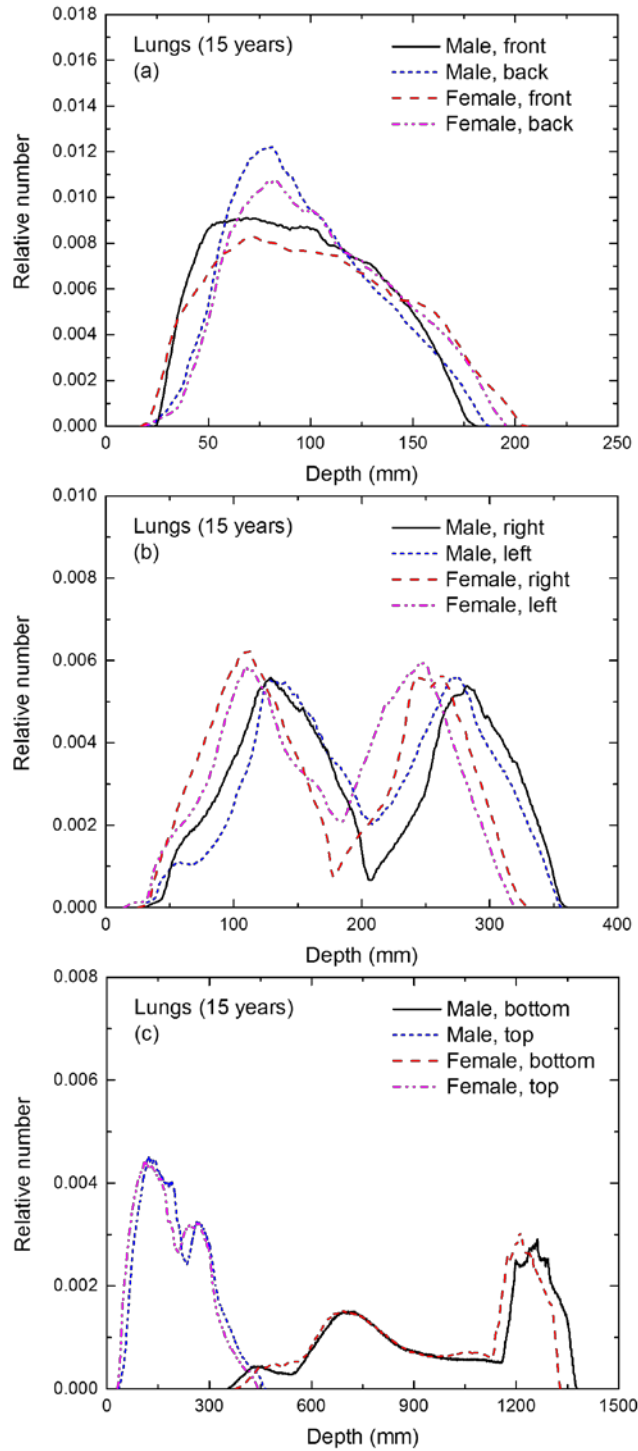
1253 below the body surface of the *15-year-old male/female phantoms* at: (a) front and back, (b) right

1254 and left, and (c) bottom and top.



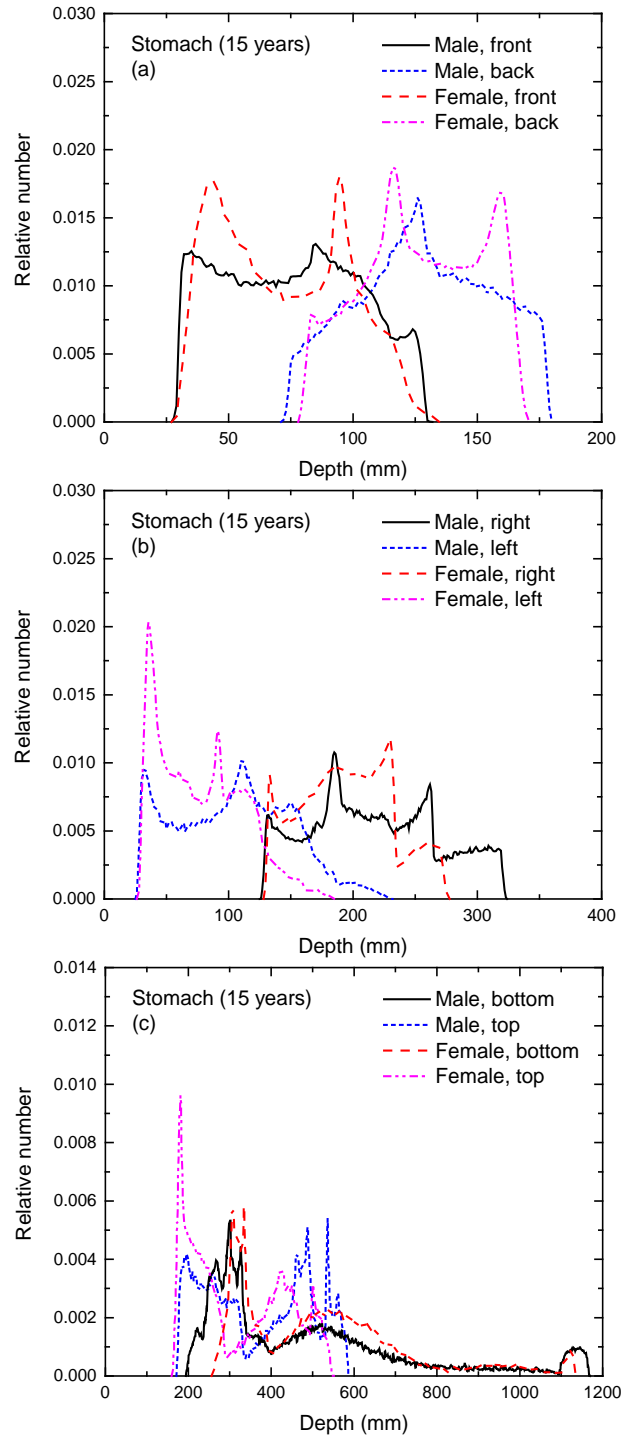
1255

1256 Fig. E.54. Distribution of depths of 10 million randomly sampled points in the *colon wall* below
 1257 the body surface of the *15-year-old male/female phantoms* at: (a) front and back, (b) right and
 1258 left, and (c) bottom and top.



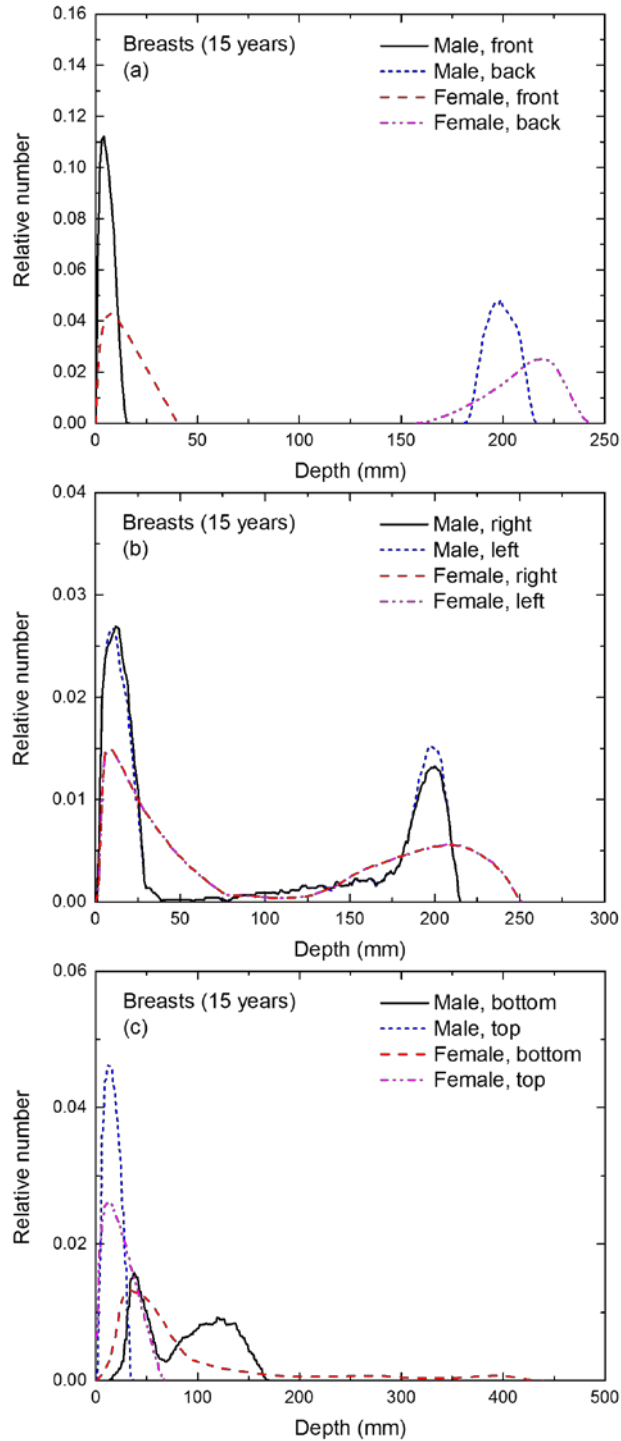
1259

1260 Fig. E.55. Distribution of depths of 10 million randomly sampled points in the *lungs* below the
 1261 body surface of the *15-year-old male/female phantoms* at: (a) front and back, (b) right and left,
 1262 and (c) bottom and top.



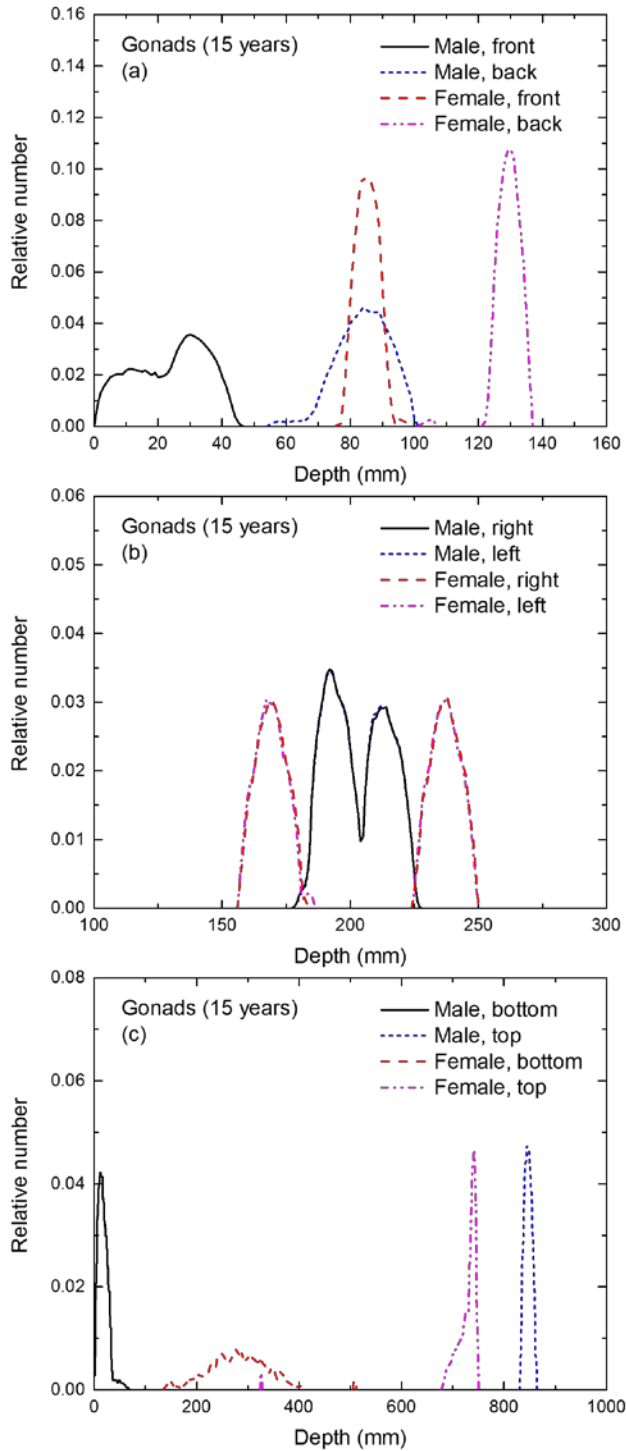
1263

1264 Fig. E.56. Distribution of depths of 10 million randomly sampled points in the *stomach wall* below
 1265 the body surface of the *15-year-old male/female phantoms* at: (a) front and back, (b) right and
 1266 left, and (c) bottom and top.



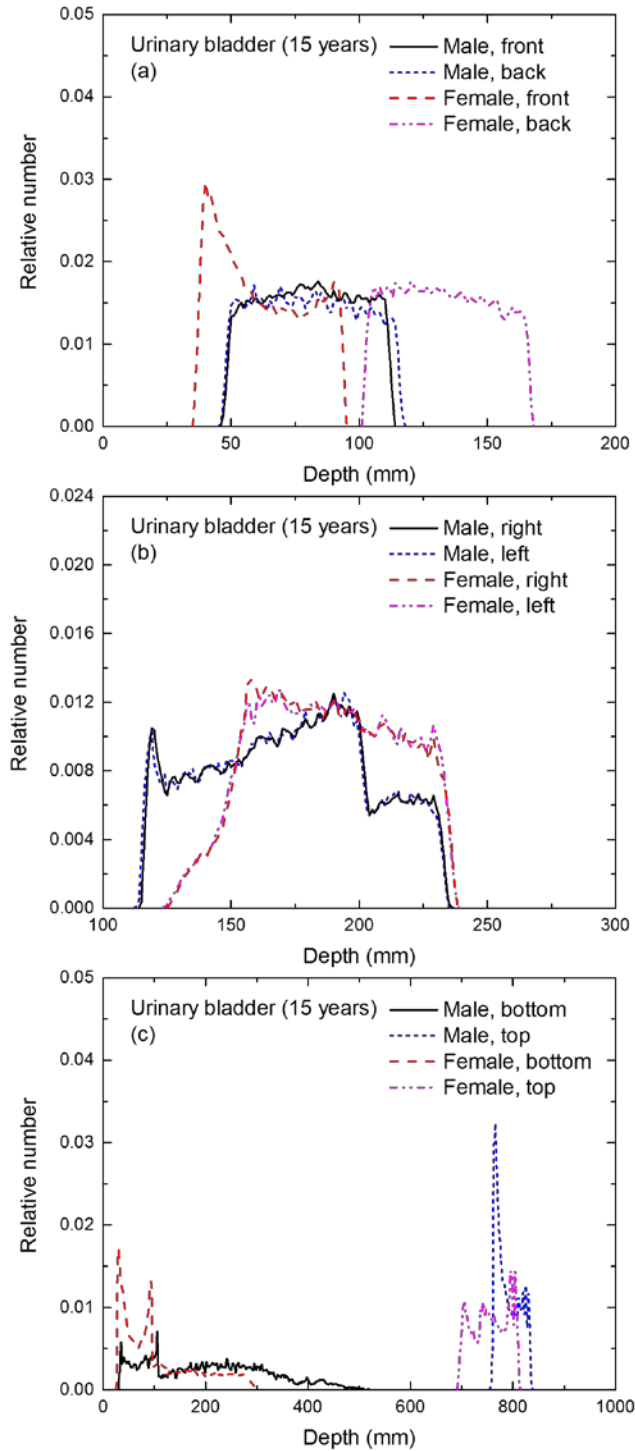
1267

1268 Fig. E.57. Distribution of depths of 10 million randomly sampled points in the *breasts* below the
 1269 body surface of the *15-year-old male/female phantoms* at: (a) front and back, (b) right and left,
 1270 and (c) bottom and top.



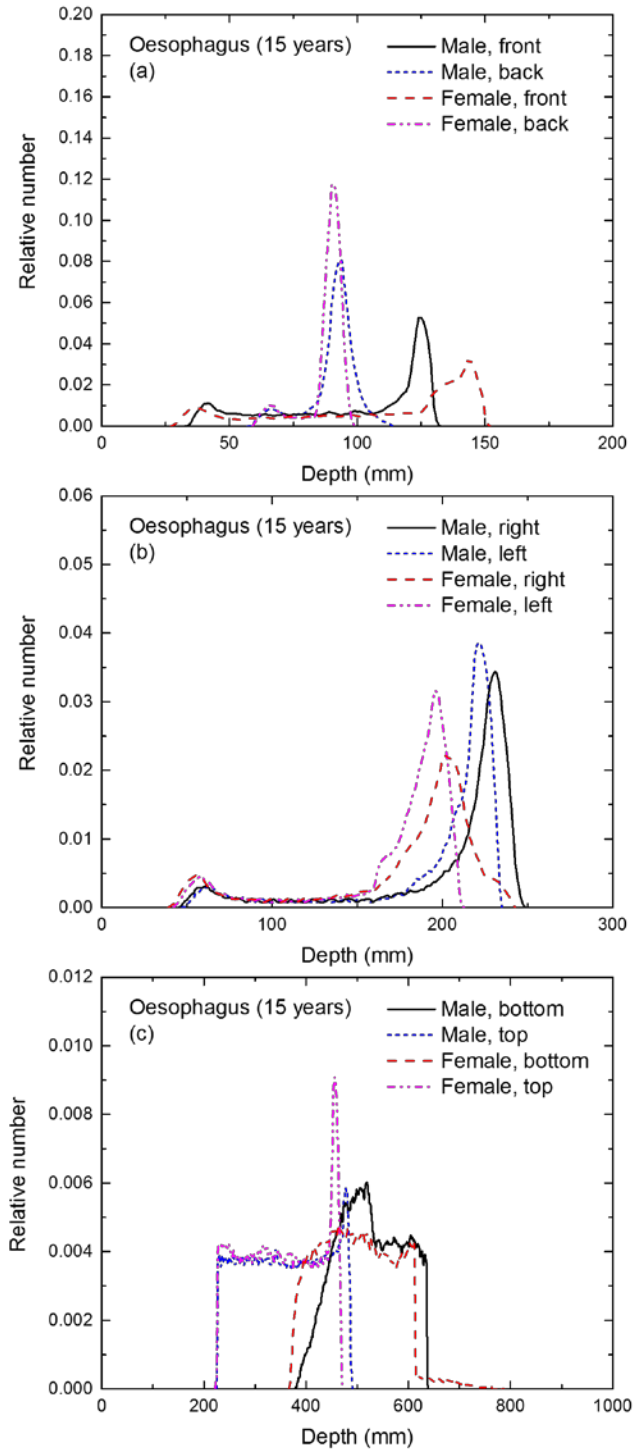
1271

1272 Fig. E.58. Distribution of depths of 10 million randomly sampled points in the *gonads* below the
 1273 body surface of the *15-year-old male/female phantoms* at: (a) front and back, (b) right and left,
 1274 and (c) bottom and top.



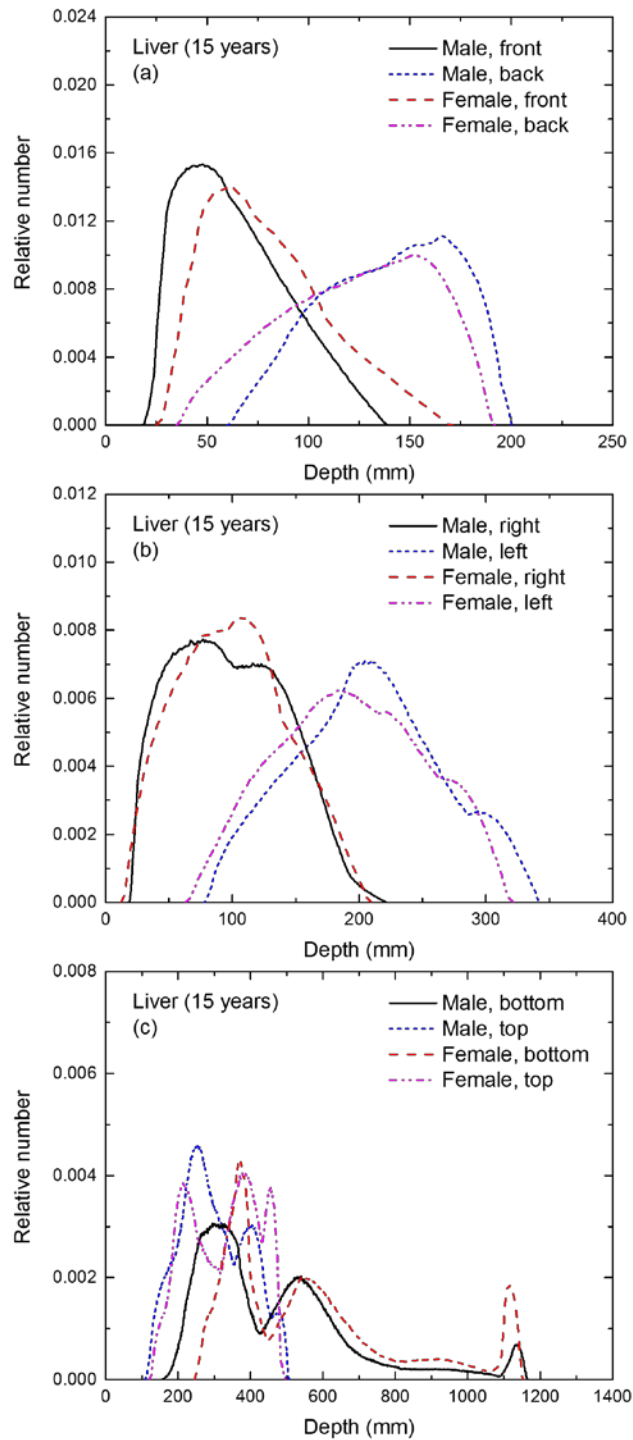
1275

1276 Fig. E.59. Distribution of depths of 10 million randomly sampled points in the *urinary bladder*
 1277 *wall* below the body surface of the *15-year-old male/female phantoms* at: (a) front and back, (b)
 1278 right and left, and (c) bottom and top.



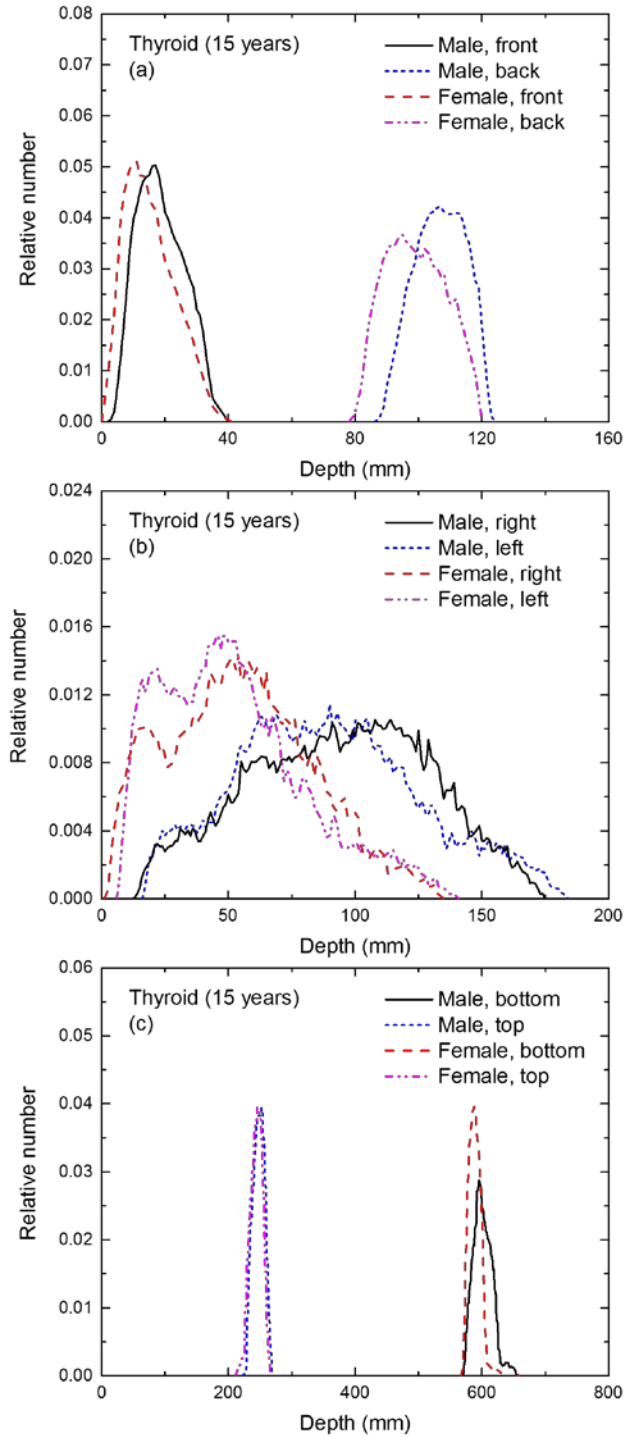
1279

1280 Fig. E.60. Distribution of depths of 10 million randomly sampled points in the *oesophagus wall*
 1281 below the body surface of the *15-year-old male/female phantoms* at: (a) front and back, (b) right
 1282 and left, and (c) bottom and top.



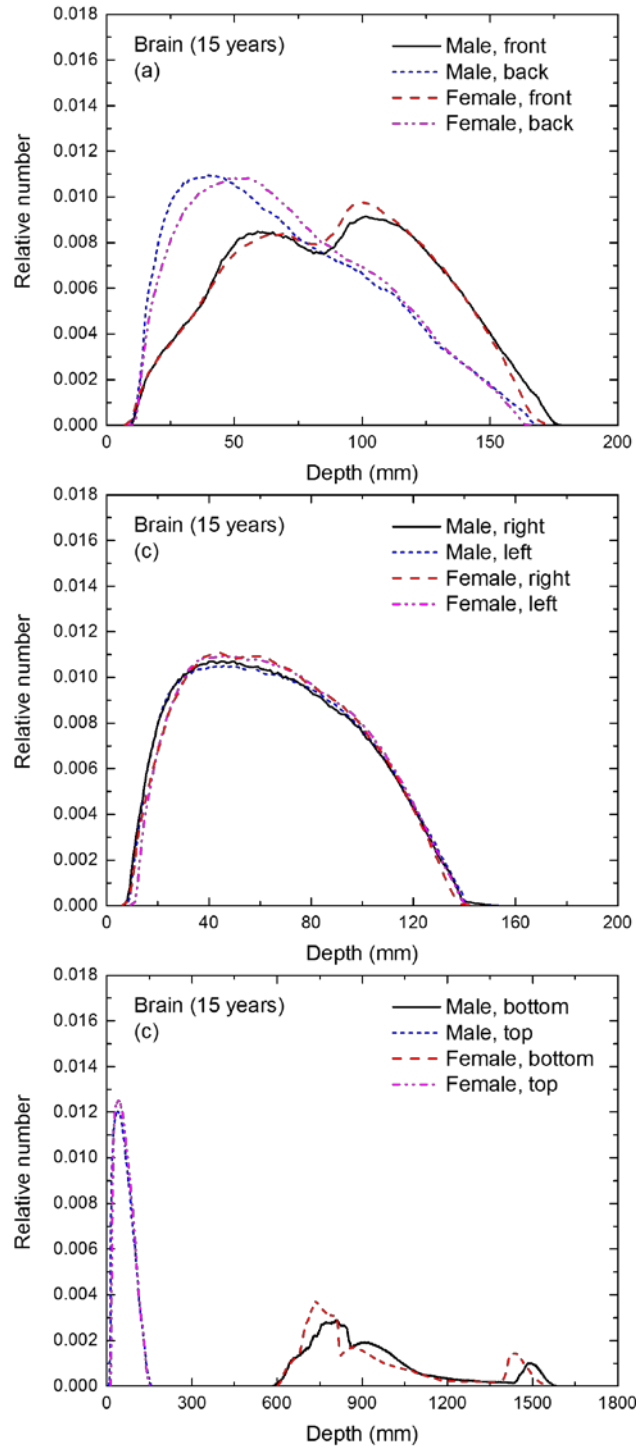
1283

1284 Fig. E.61. Distribution of depths of 10 million randomly sampled points in the *liver* below the
 1285 body surface of the *15-year-old male/female phantoms* at: (a) front and back, (b) right and left,
 1286 and (c) bottom and top.



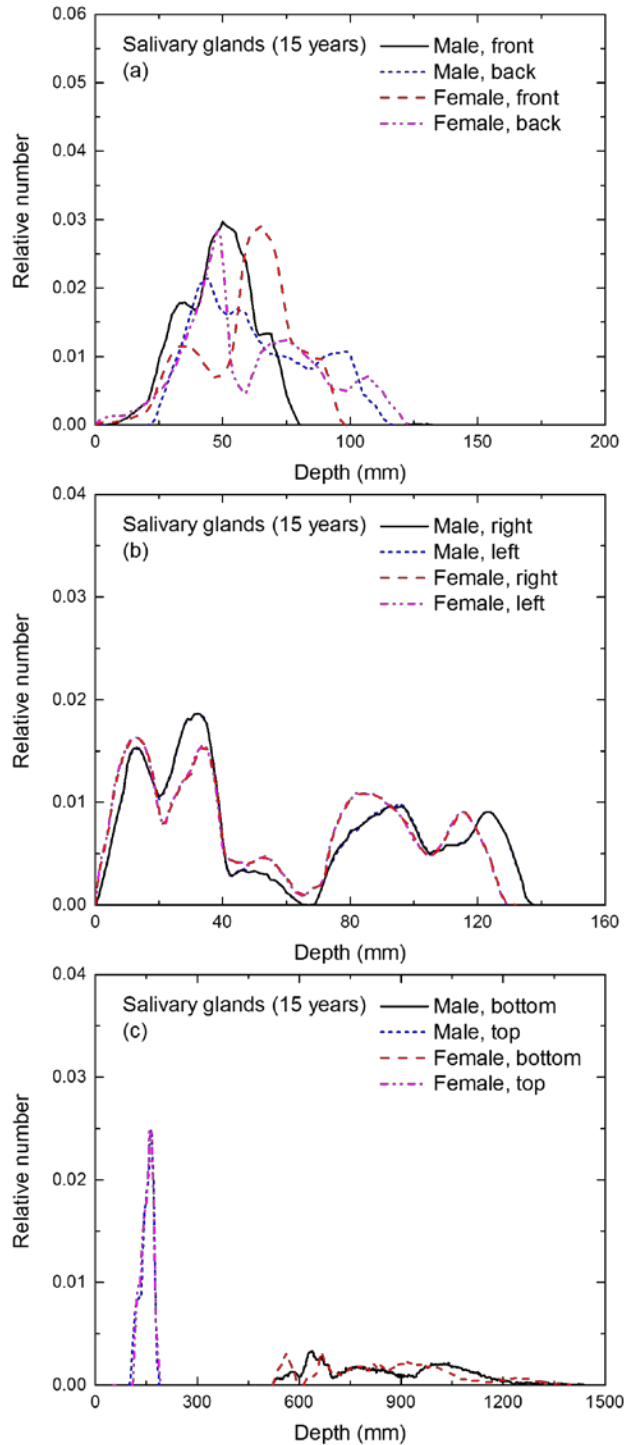
1287

1288 Fig. E.62. Distribution of depths of 10 million randomly sampled points in the *thyroid* below the
 1289 body surface of the *15-year-old male/female phantoms* at: (a) front and back, (b) right and left,
 1290 and (c) bottom and top.



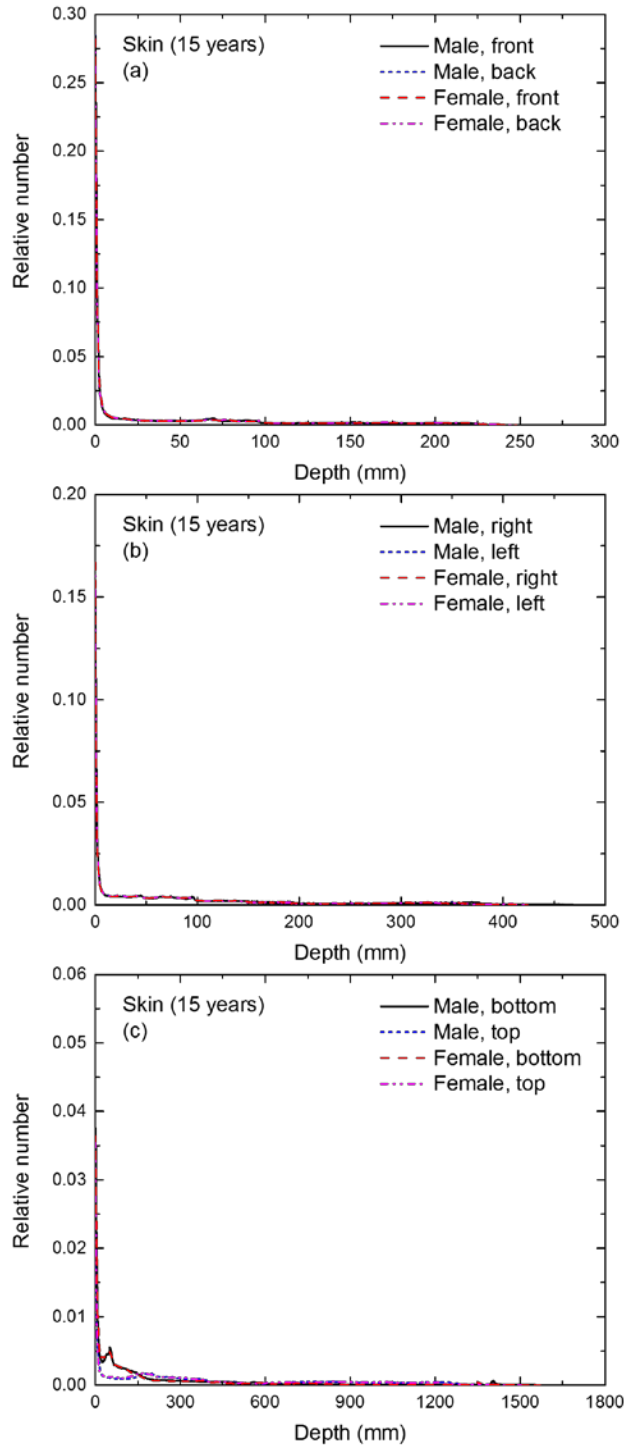
1291

1292 Fig. E.63. Distribution of depths of 10 million randomly sampled points in the *brain* below the
 1293 body surface of the *15-year-old male/female phantoms* at: (a) front and back, (b) right and left,
 1294 and (c) bottom and top.



1295

1296 Fig. E.64. Distribution of depths of 10 million randomly sampled points in the *salivary glands*
 1297 below the body surface of the *15-year-old male/female phantoms* at: (a) front and back, (b) right
 1298 and left, and (c) bottom and top.



1299

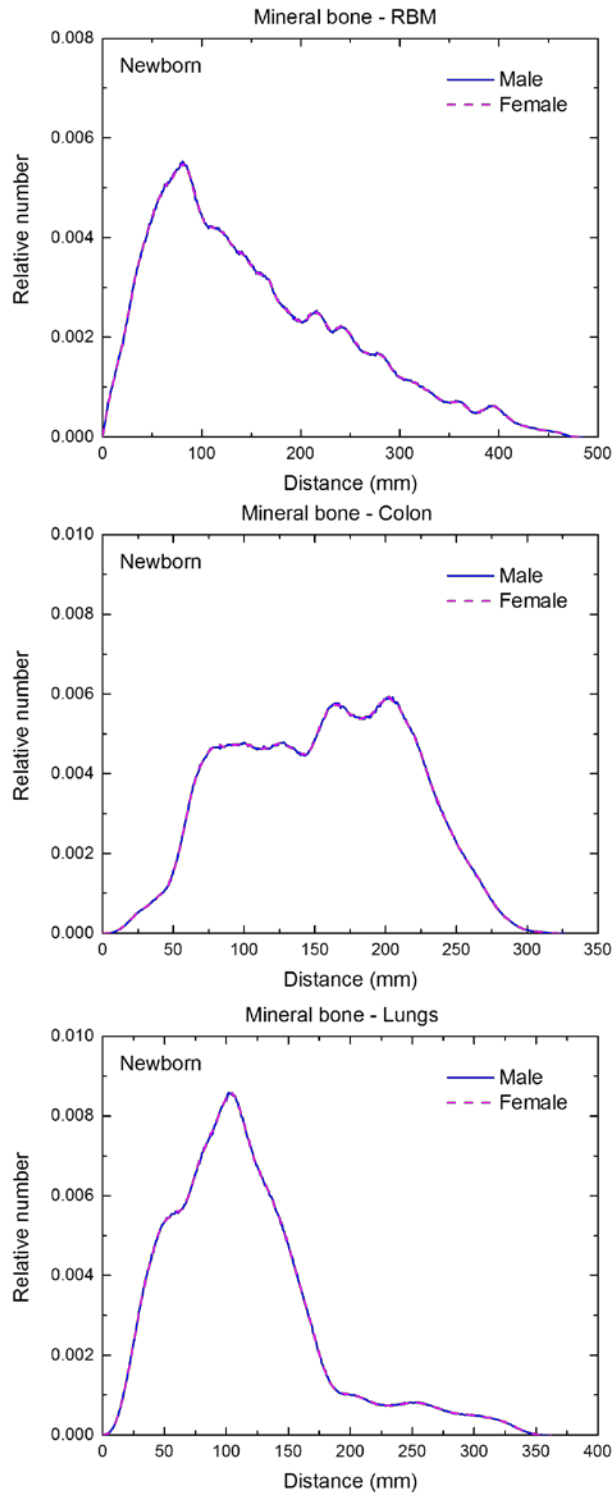
1300 Fig. E.65. Distribution of depths of 10 million randomly sampled points in the *skin* below the body
 1301 surface of the *15-year-old male/female phantoms* at: (a) front and back, (b) right and left, and (c)
 1302 bottom and top.

1303 **ANNEX F. CHORD-LENGTH DISTRIBUTIONS BETWEEN SELECTED**
1304 **ORGAN PAIRS (SOURCE/TARGET TISSUES)**

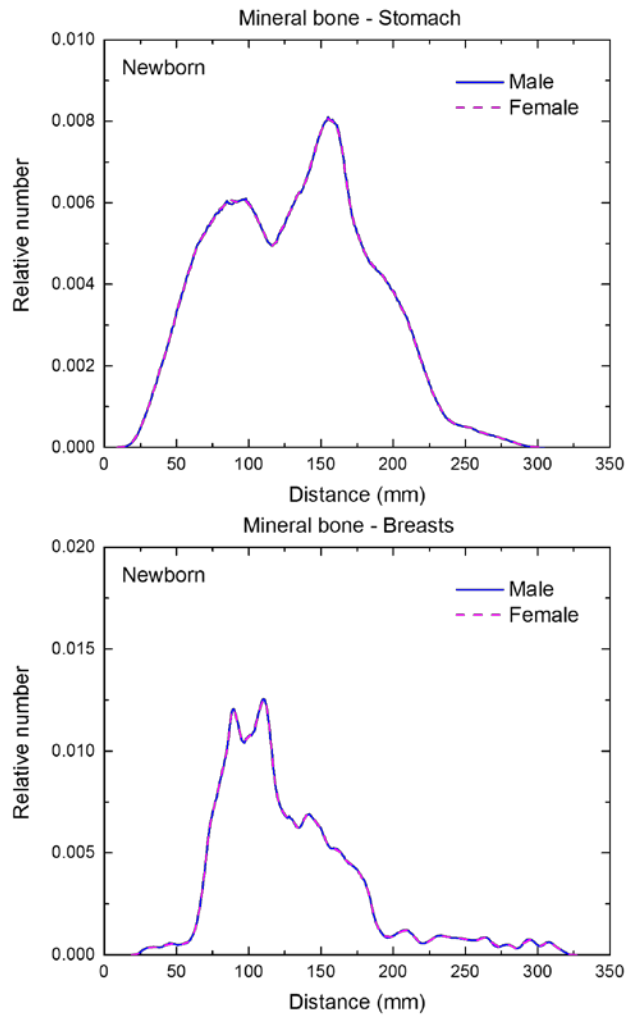
1305 (F 1) In Figs. F.1–F.4, chord-length distributions are shown between mineral bone, liver,
1306 lungs, and thyroid as source organs and the target organs red bone marrow, colon wall, lungs,
1307 stomach wall, and breast. Ten million point pairs have been sampled randomly in the organs
1308 considered, and the distributions of the resulting chord-lengths evaluated.

1309 (F 2) The distance between source and target region is a parameter influencing the specific
1310 absorbed fractions in internal dosimetry.

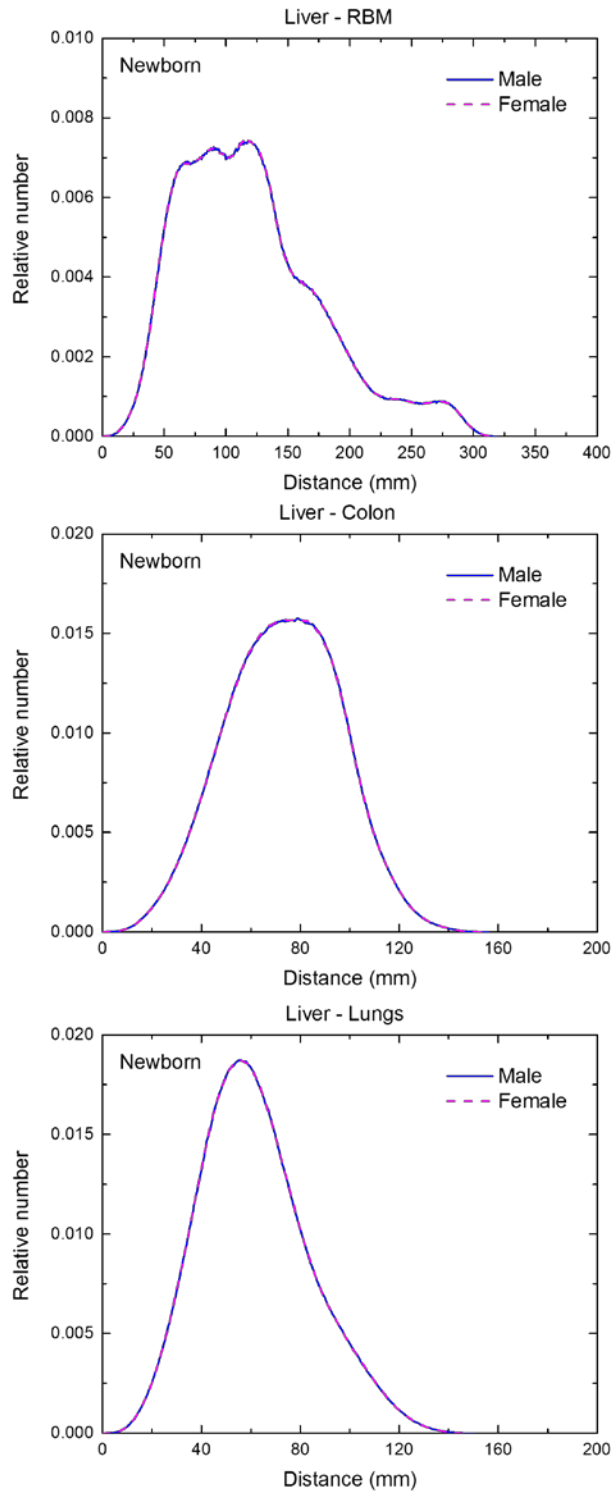
1311



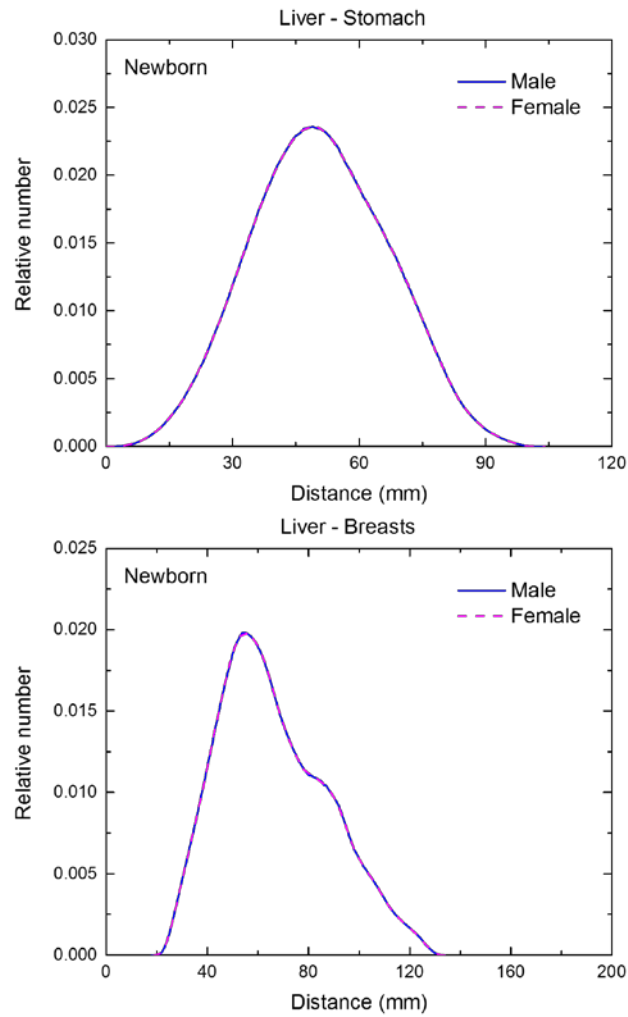
1312
 1313 Fig. F.1. Distribution of distances between 10 million randomly sampled point pairs in *mineral*
 1314 *bone* (source region) and red bone marrow, colon, lungs, stomach wall, and breast (target regions)
 1315 in the *newborn male/female phantoms*.



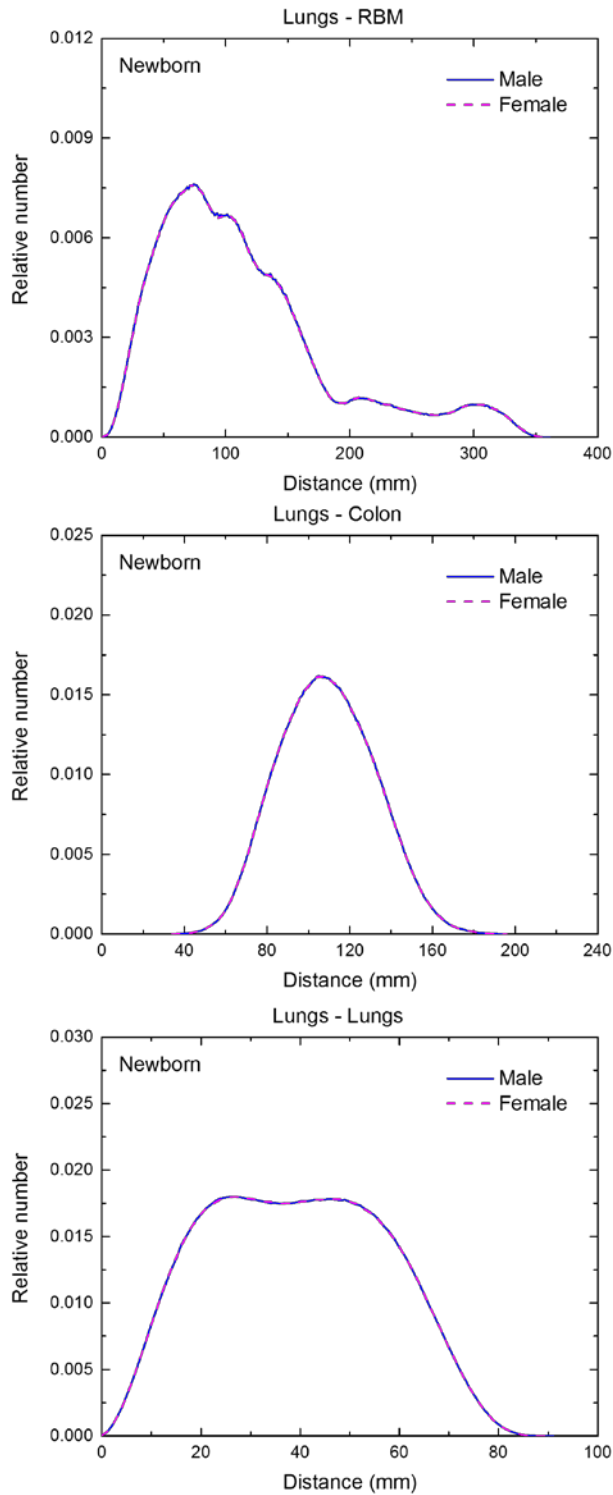
1316
1317 Fig. F.1. (continued)



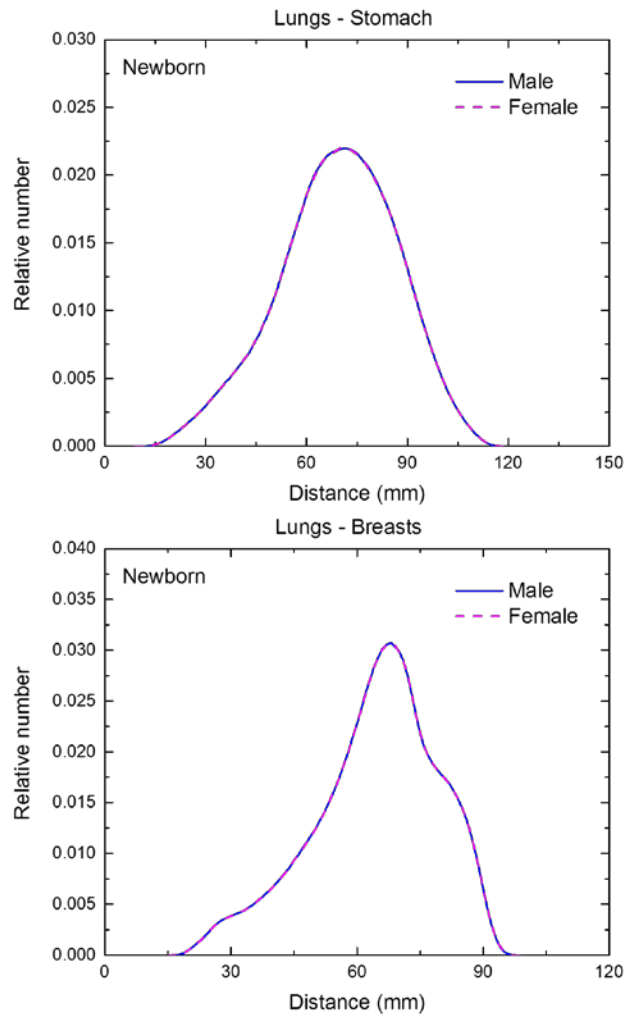
1318
 1319 Fig. F.2. Distribution of distances between 10 million randomly sampled point pairs in *liver*
 1320 (source region) and red bone marrow, colon, lungs, stomach wall, and breast (target regions) in
 1321 the *newborn male/female phantoms*.



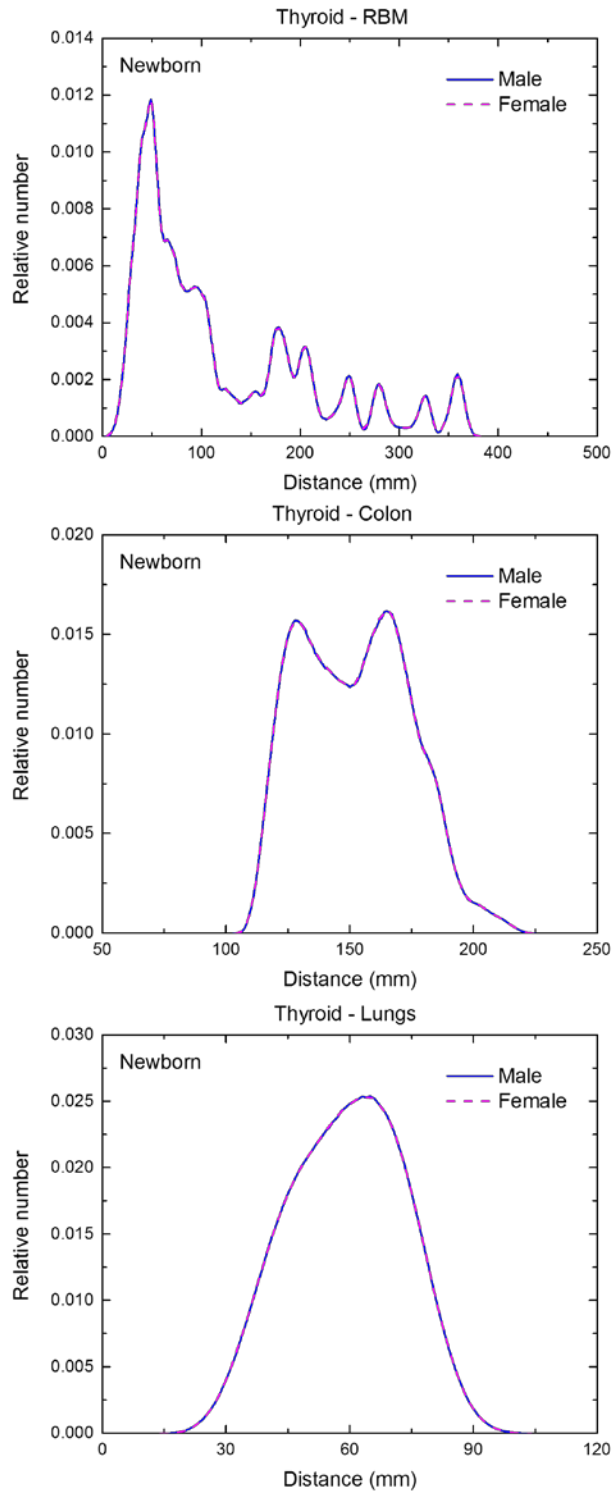
1322
1323 Fig. F.2. (continued)



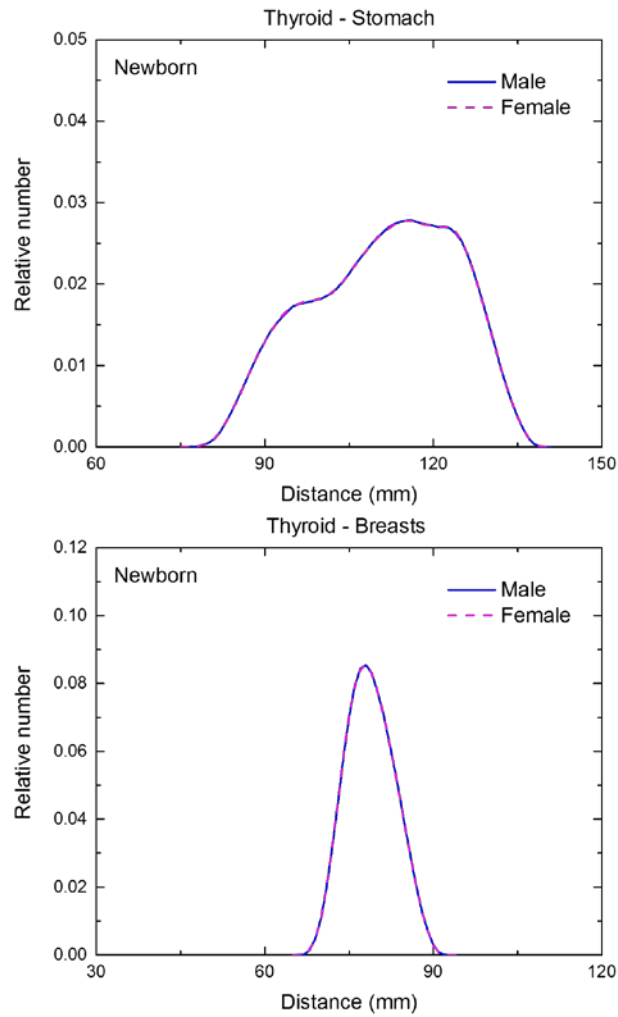
1324
 1325 Fig. F.3. Distribution of distances between 10 million randomly sampled point pairs in *lungs*
 1326 (source region) and red bone marrow, colon, lungs, stomach wall, and breast (target regions) in
 1327 the *newborn male/female phantoms*.



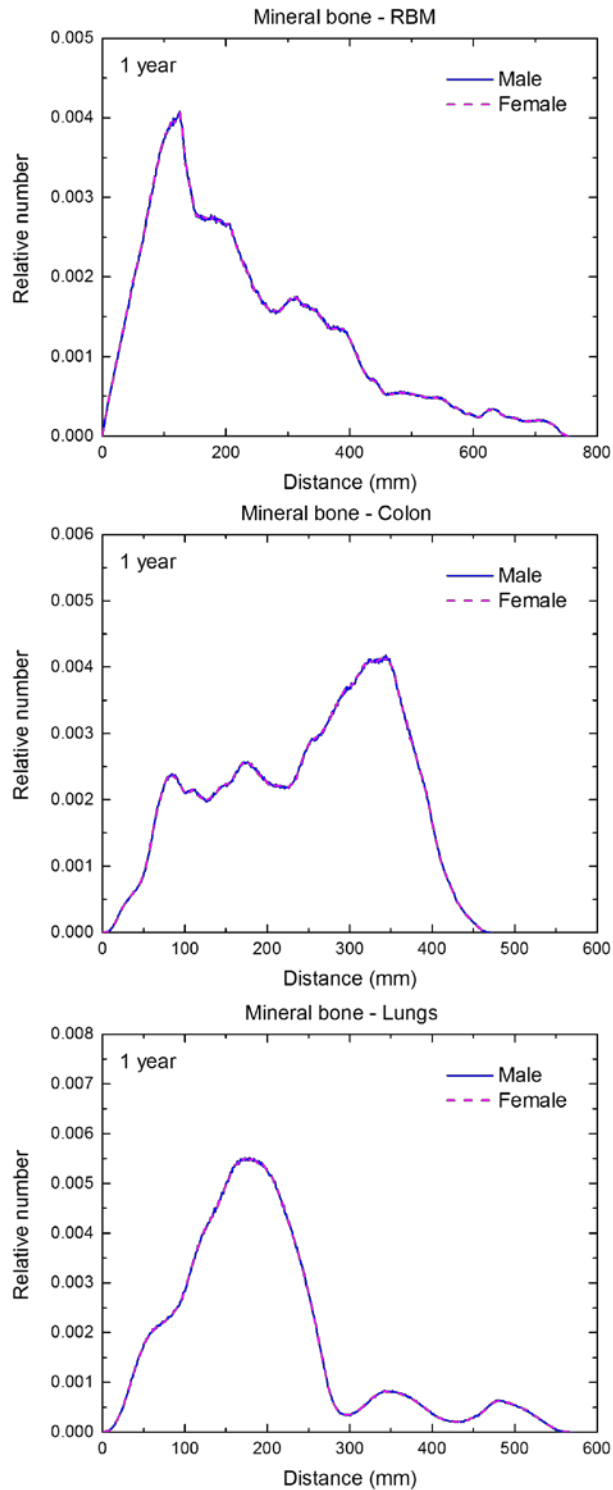
1328
1329 Fig. F.3. (continued)
1330



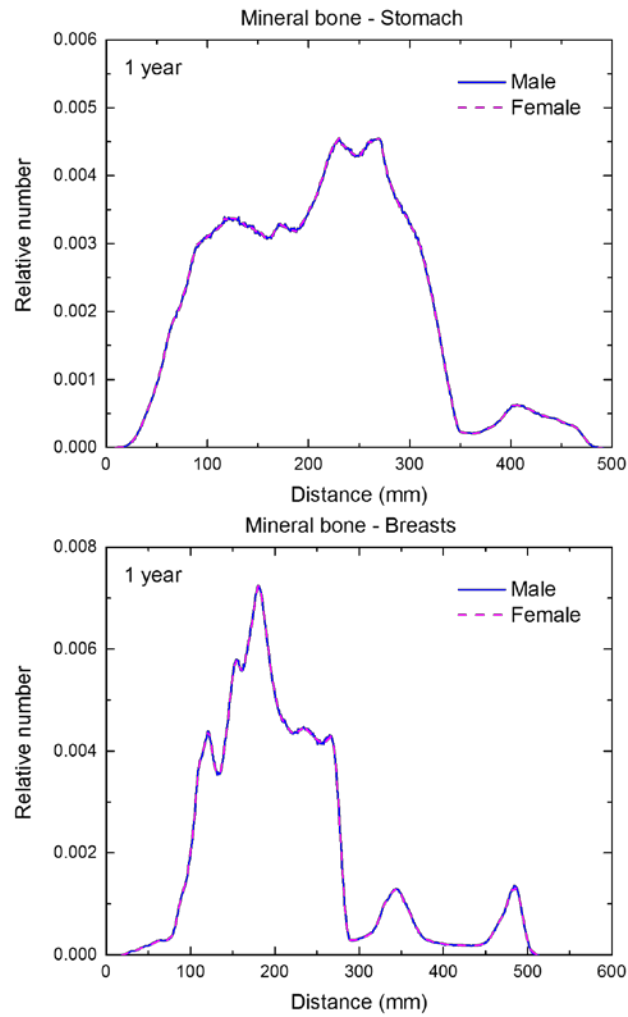
1331
 1332 Fig. F.4. Distribution of distances between 10 million randomly sampled point pairs in *thyroid*
 1333 (source region) and red bone marrow, colon, lungs, stomach wall, and breast (target regions) in
 1334 the *newborn male/female phantoms*.



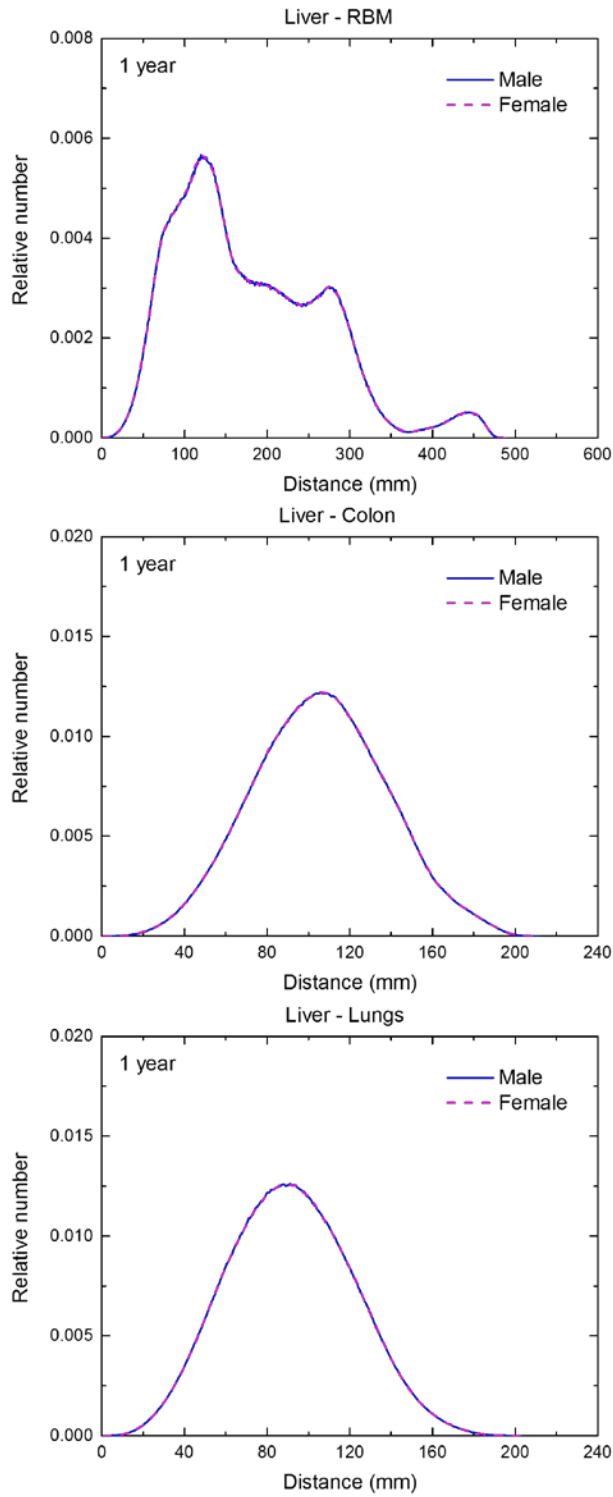
1335
1336 Fig. F.4. (continued)
1337



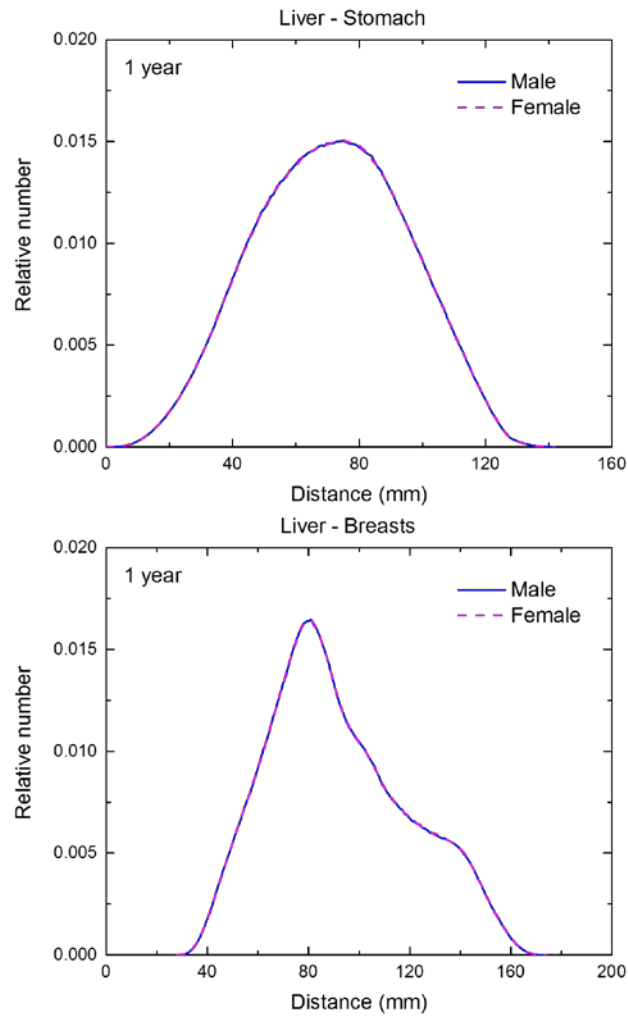
1338
 1339 Fig. F.5. Distribution of distances between 10 million randomly sampled point pairs in *mineral*
 1340 *bone* (source region) and red bone marrow, colon, lungs, stomach wall, and breast (target regions)
 1341 in the *1-year-old male/female phantoms*.



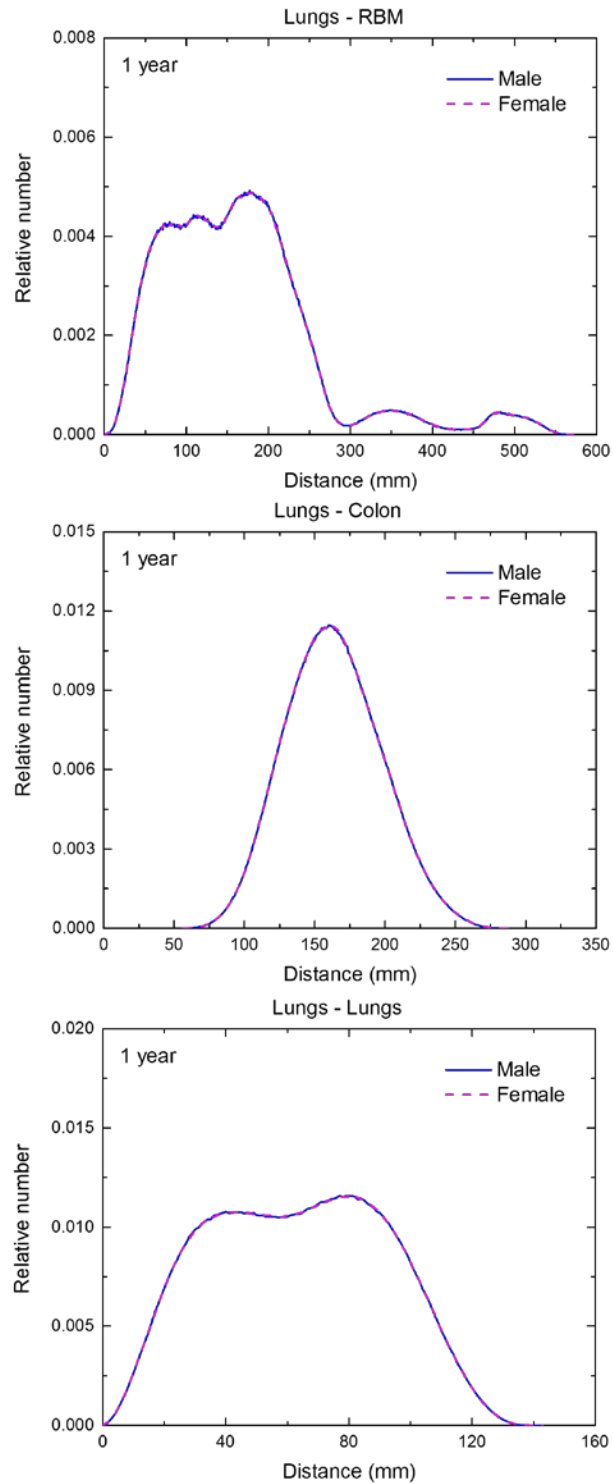
1342
1343 Fig. F.5. (continued)



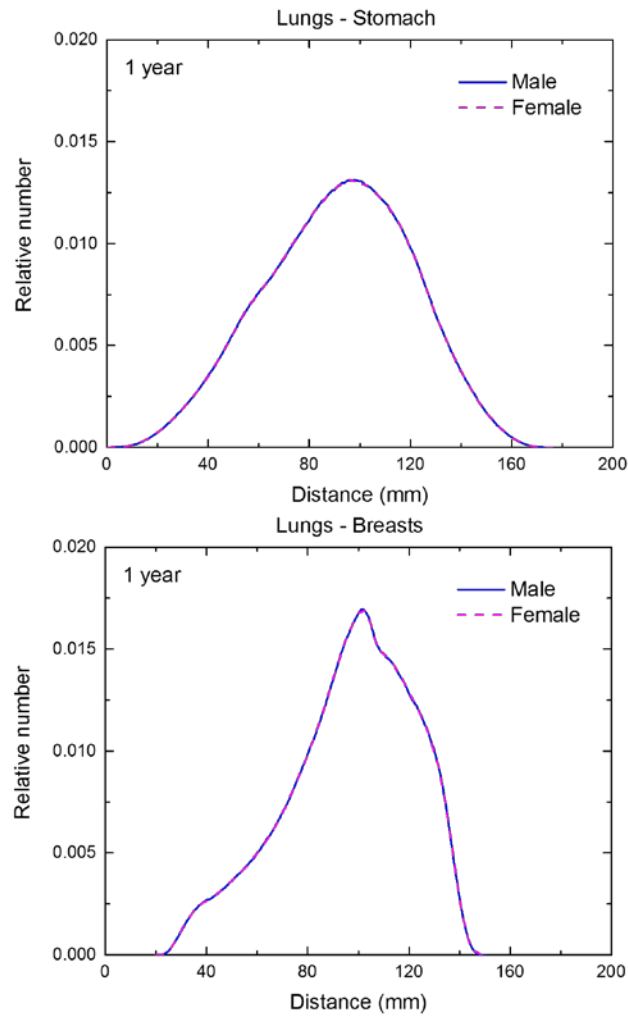
1344
 1345 Fig. F.6. Distribution of distances between 10 million randomly sampled point pairs in *liver*
 1346 (source region) and red bone marrow, colon, lungs, stomach wall, and breast (target regions) in
 1347 the *1-year-old male/female phantoms*.



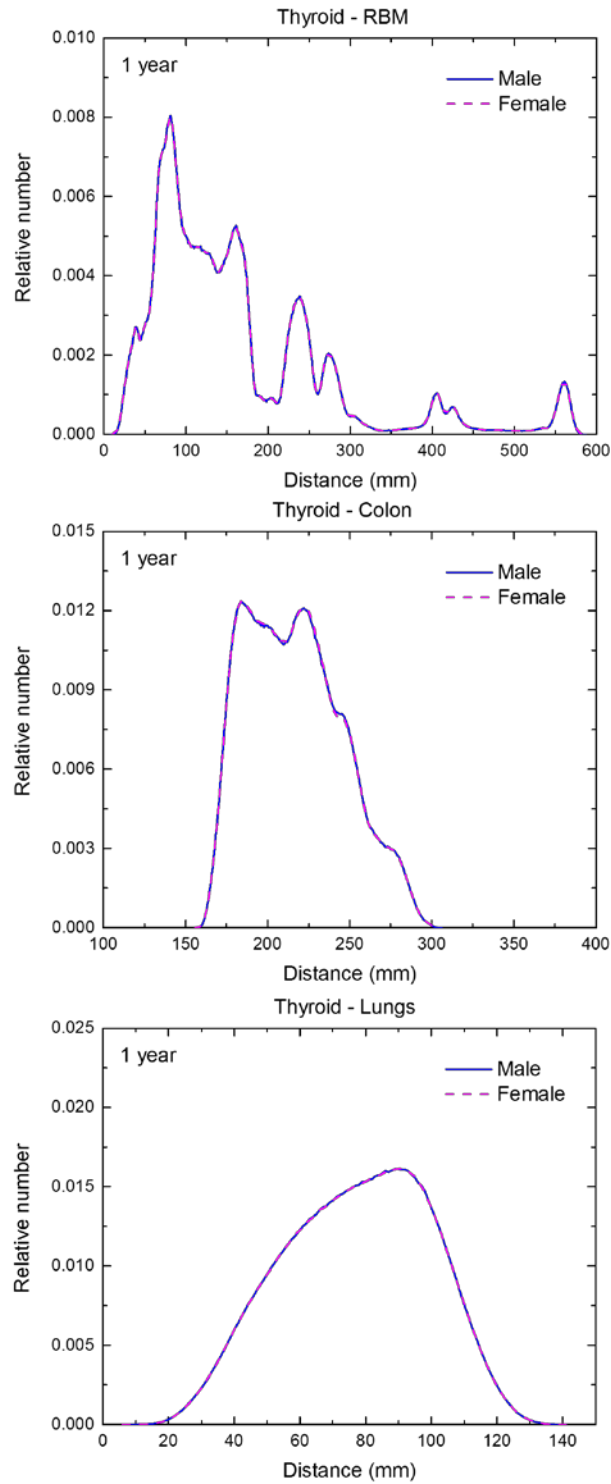
1348
1349 Fig. F.6. (continued)
1350



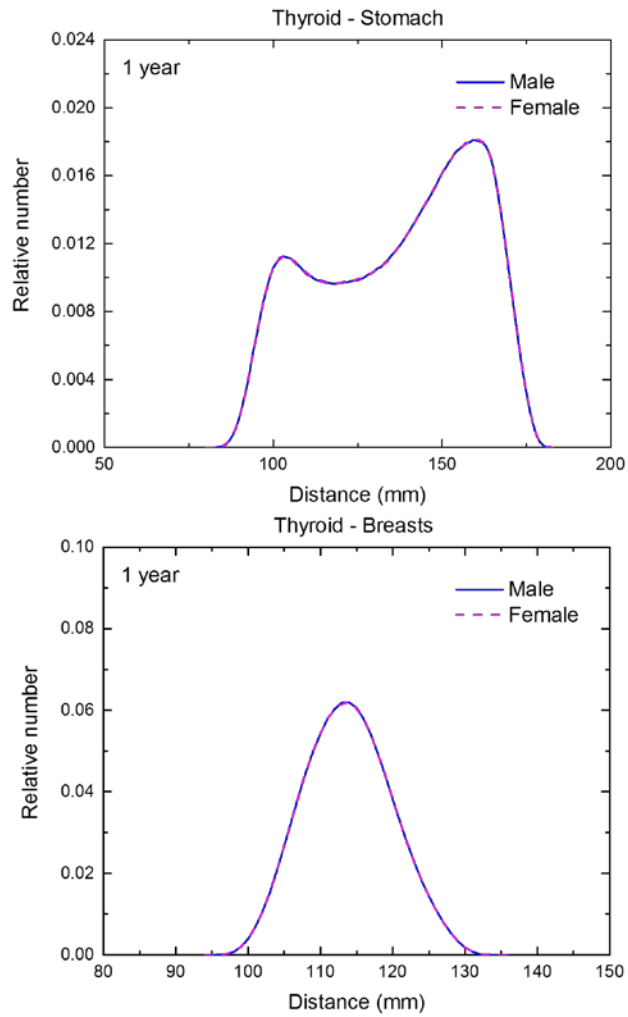
1351
 1352 Fig. F.7. Distribution of distances between 10 million randomly sampled point pairs in *lungs*
 1353 (source region) and red bone marrow, colon, lungs, stomach wall, and breast (target regions) in
 1354 the *1-year-old male/female phantoms*.



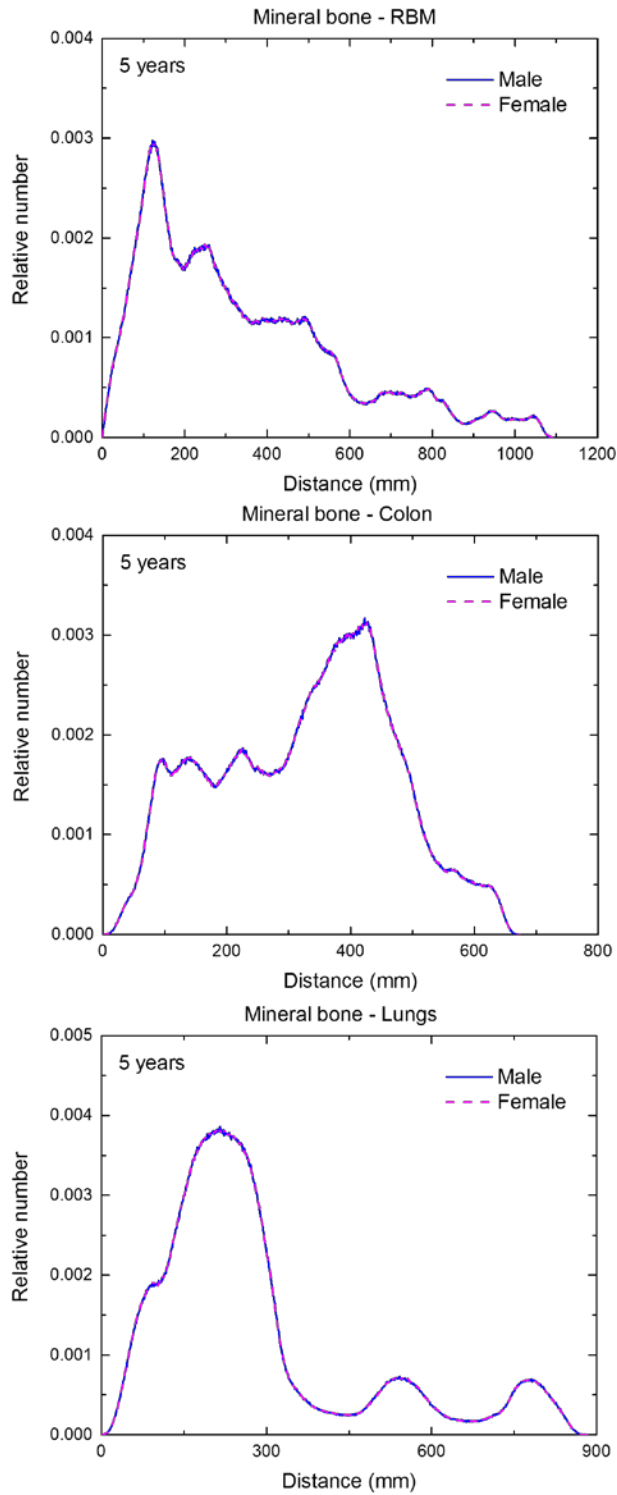
1355
1356 Fig. F.7. (continued)



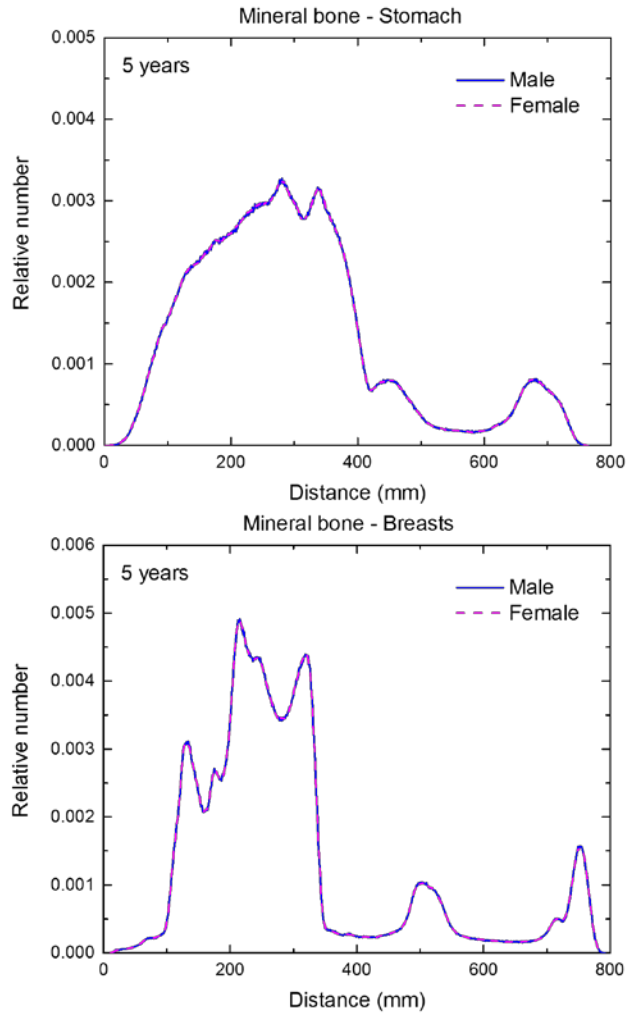
1357
 1358 Fig. F.8. Distribution of distances between 10 million randomly sampled point pairs in *thyroid*
 1359 (source region) and red bone marrow, colon, lungs, stomach wall, and breast (target regions) in
 1360 the *1-year-old male/female phantoms*.



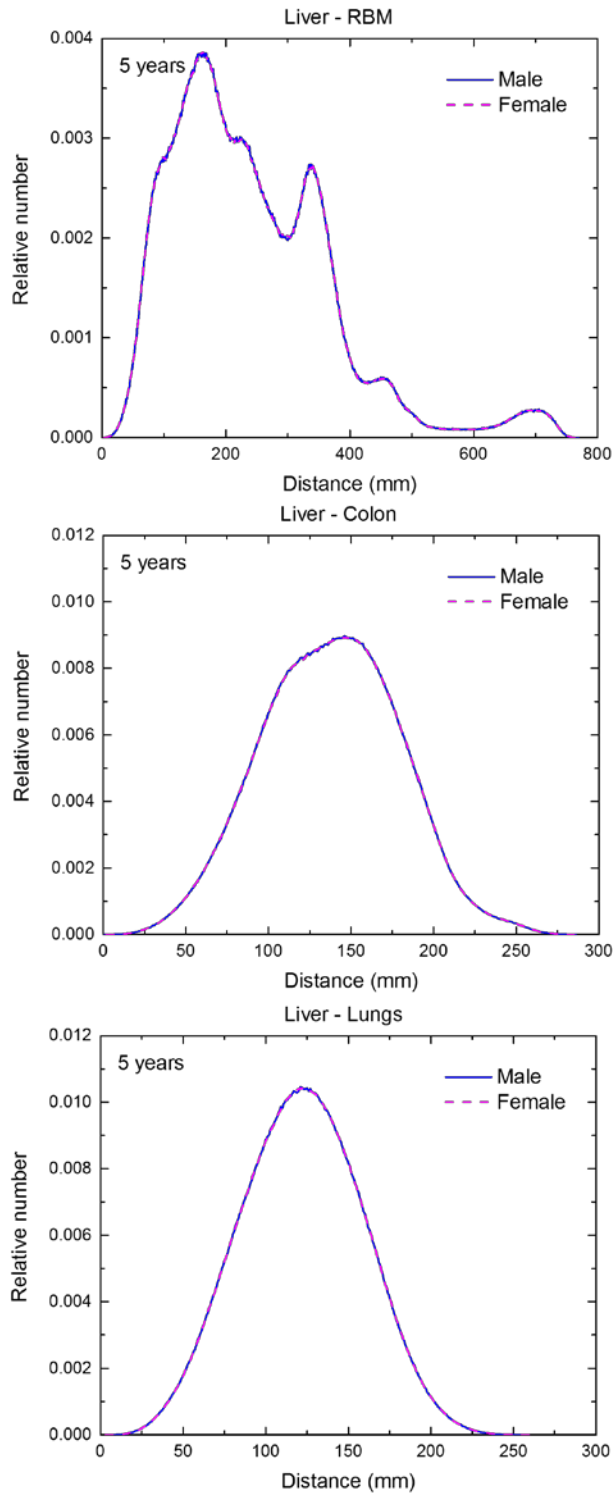
1361
1362 Fig. F.8. (continued)
1363



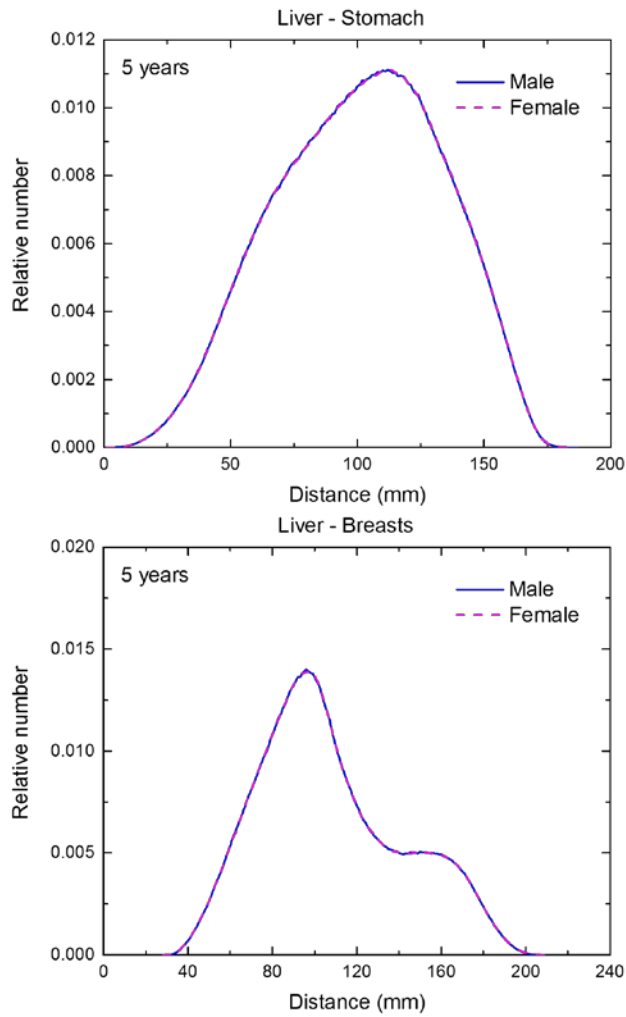
1364
 1365 Fig. F.9. Distribution of distances between 10 million randomly sampled point pairs in *mineral*
 1366 *bone* (source region) and red bone marrow, colon, lungs, stomach wall, and breast (target regions)
 1367 in the 5-year-old male/female phantoms.



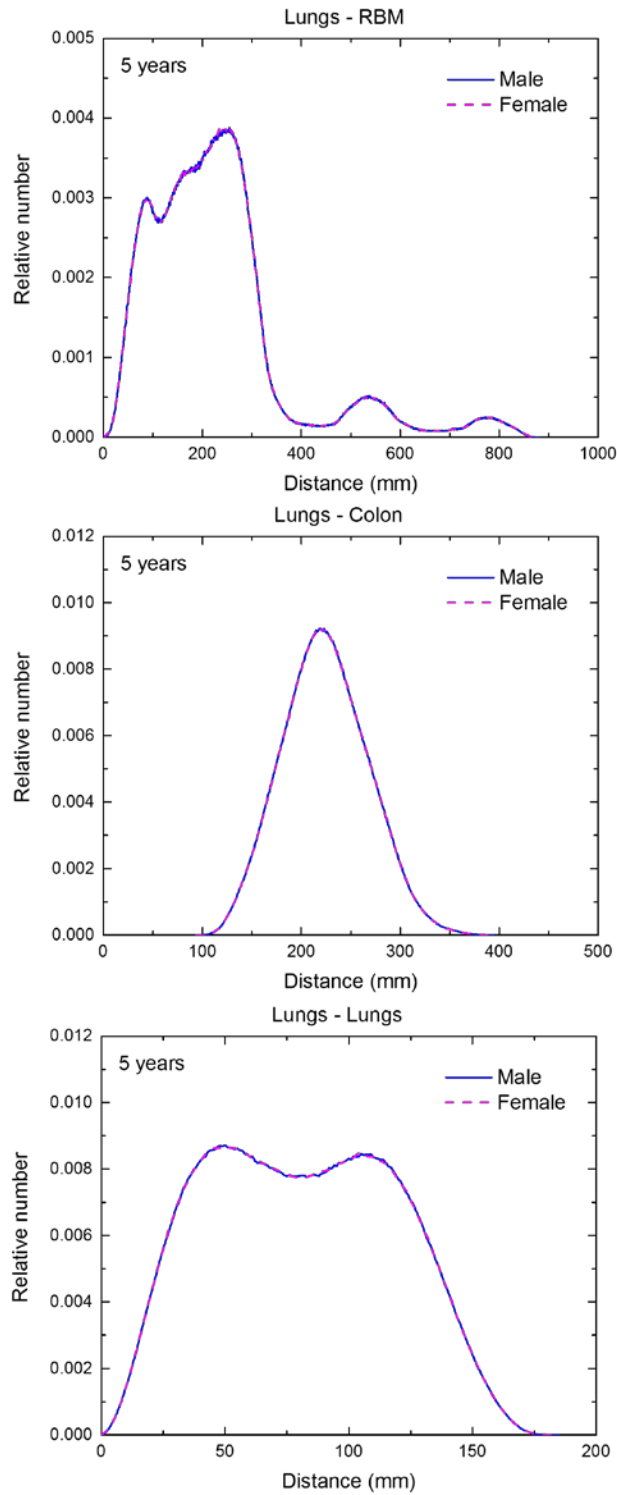
1368
1369 Fig. F.9. (continued)



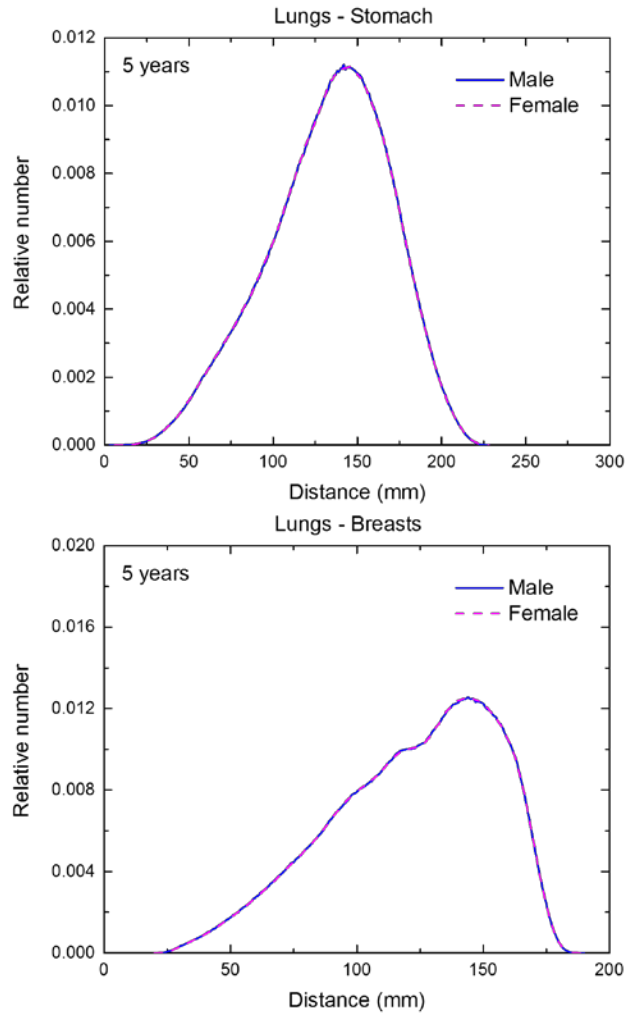
1370
 1371 Fig. F.10. Distribution of distances between 10 million randomly sampled point pairs in *liver*
 1372 (source region) and red bone marrow, colon, lungs, stomach wall, and breast (target regions) in
 1373 the *5-year-old male/female phantoms*.



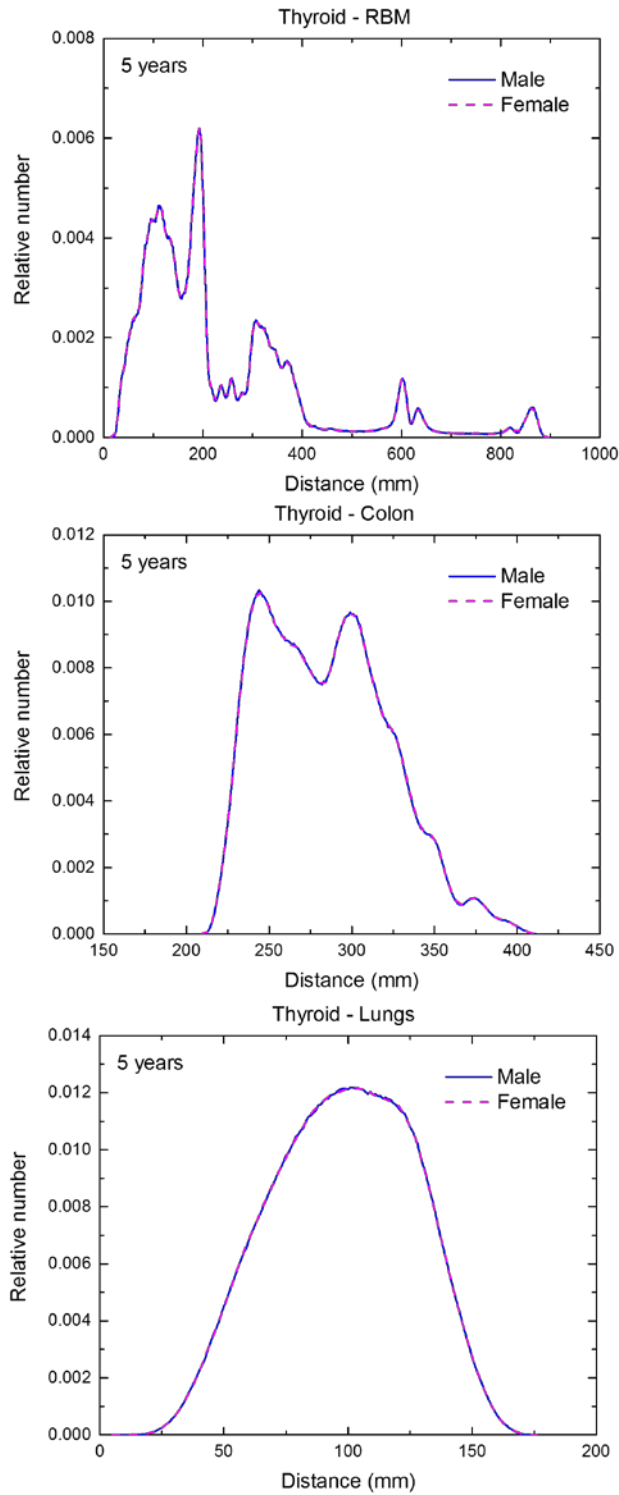
1374
 1375 Fig. F.10. (continued)



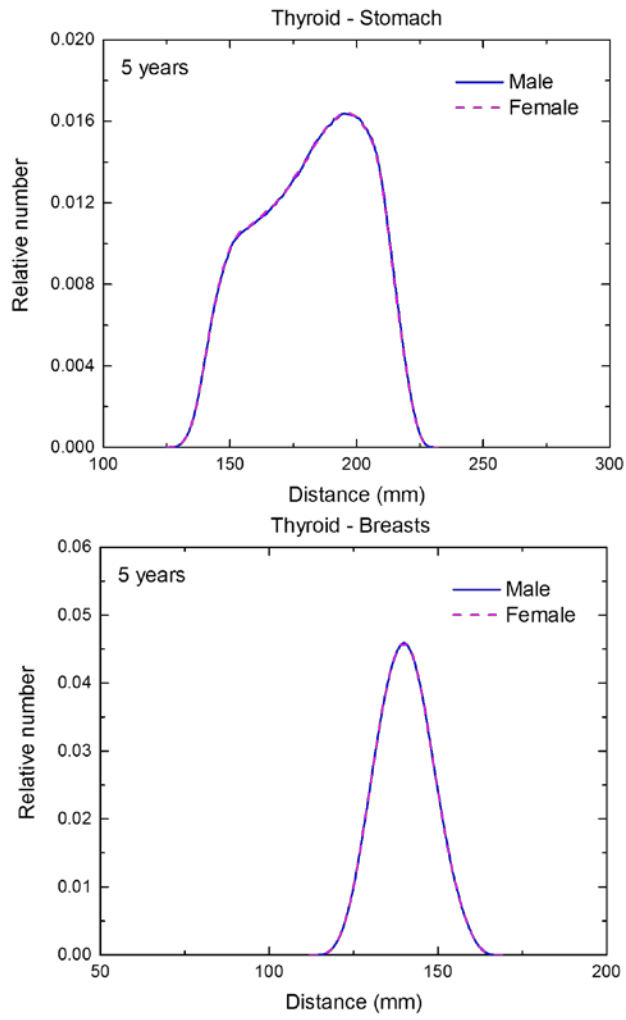
1376
 1377 Fig. F.11. Distribution of distances between 10 million randomly sampled point pairs in *lungs*
 1378 (source region) and red bone marrow, colon, lungs, stomach wall, and breast (target regions) in
 1379 the *5-year-old male/female phantoms*.



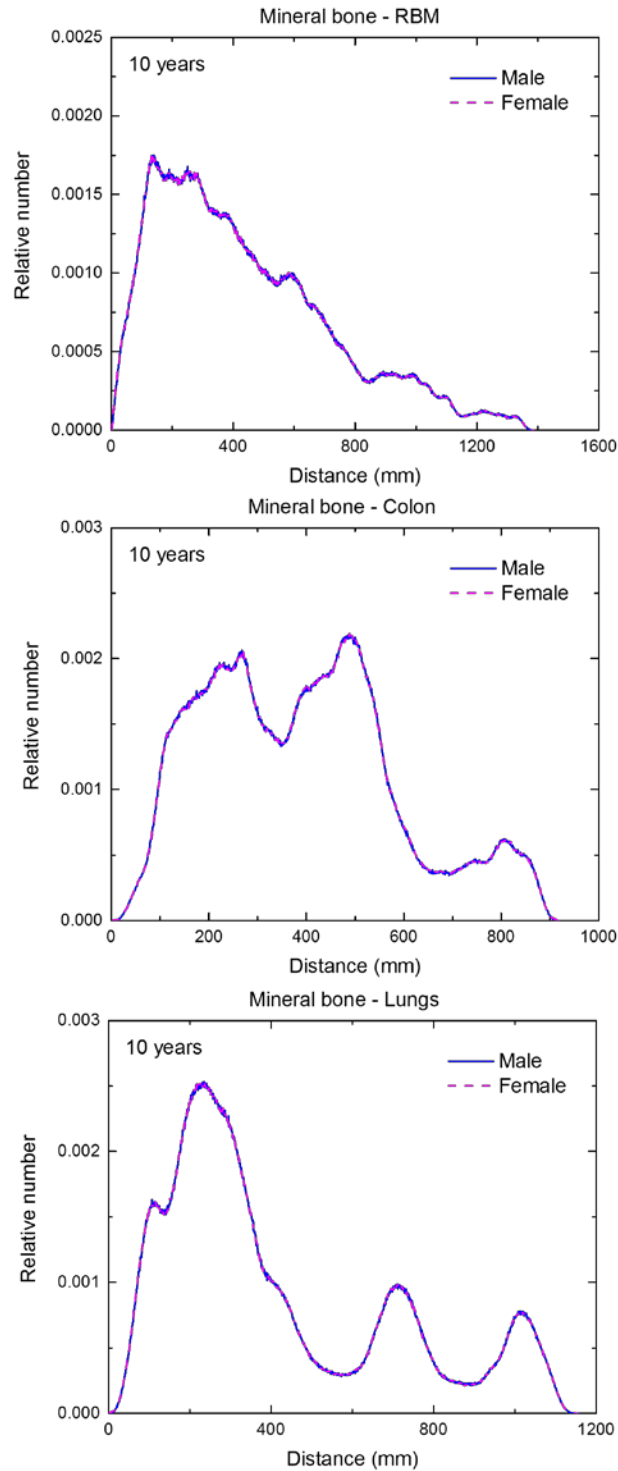
1380
1381 Fig. F.11. (continued)



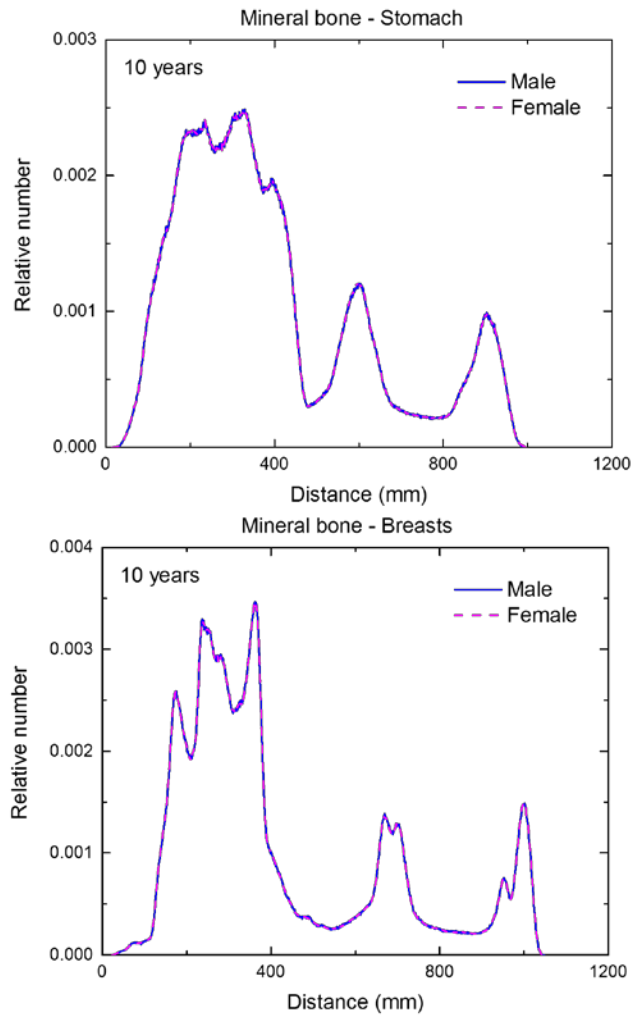
1382
 1383 Fig. F.12. Distribution of distances between 10 million randomly sampled point pairs in *thyroid*
 1384 (source region) and red bone marrow, colon, lungs, stomach wall, and breast (target regions) in
 1385 the *5-year-old male/female phantoms*.



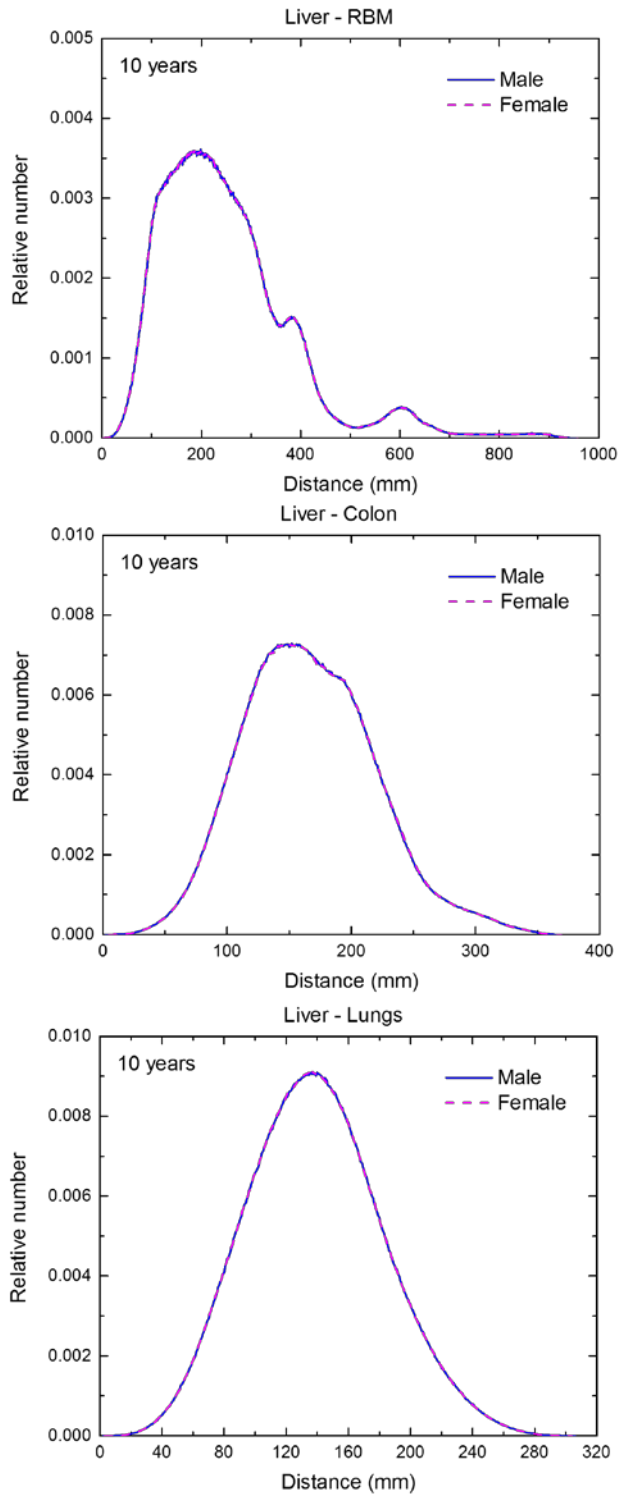
1386
1387 Fig. F.12. (continued)
1388



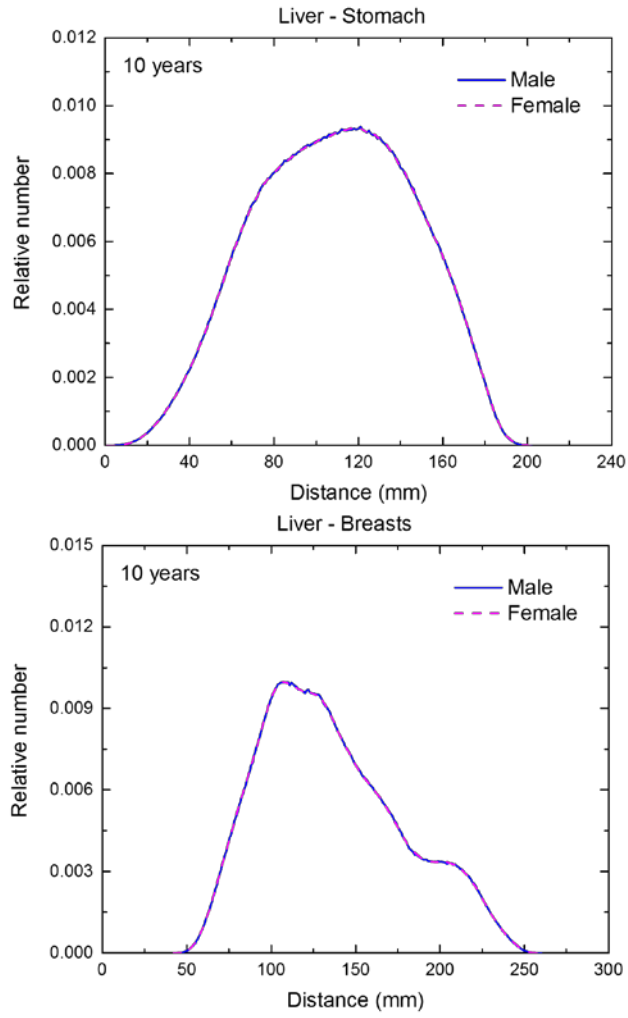
1389 Fig. F.13. Distribution of distances between 10 million randomly sampled point pairs in *mineral*
 1390 *bone* (source region) and red bone marrow, colon, lungs, stomach wall, and breast (target regions)
 1391 in the *10-year-old male/female phantoms*.
 1392



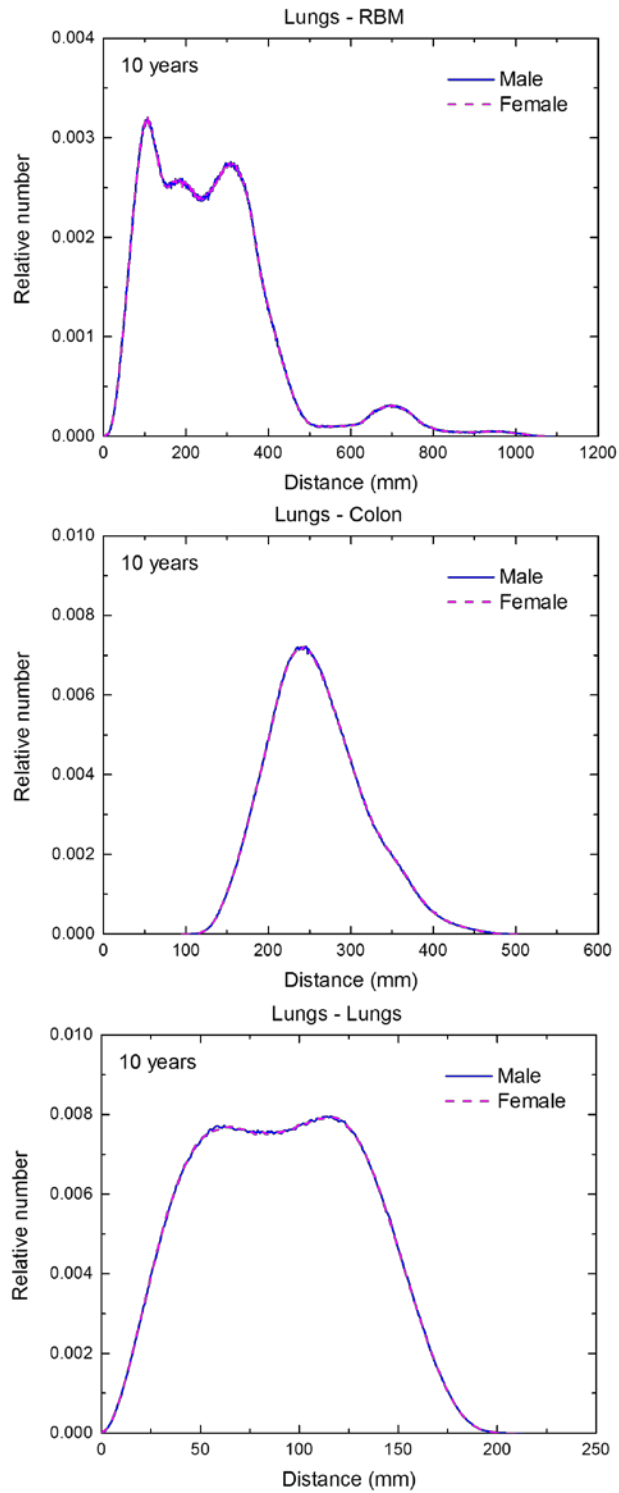
1393
1394 Fig. F.13. (continued)



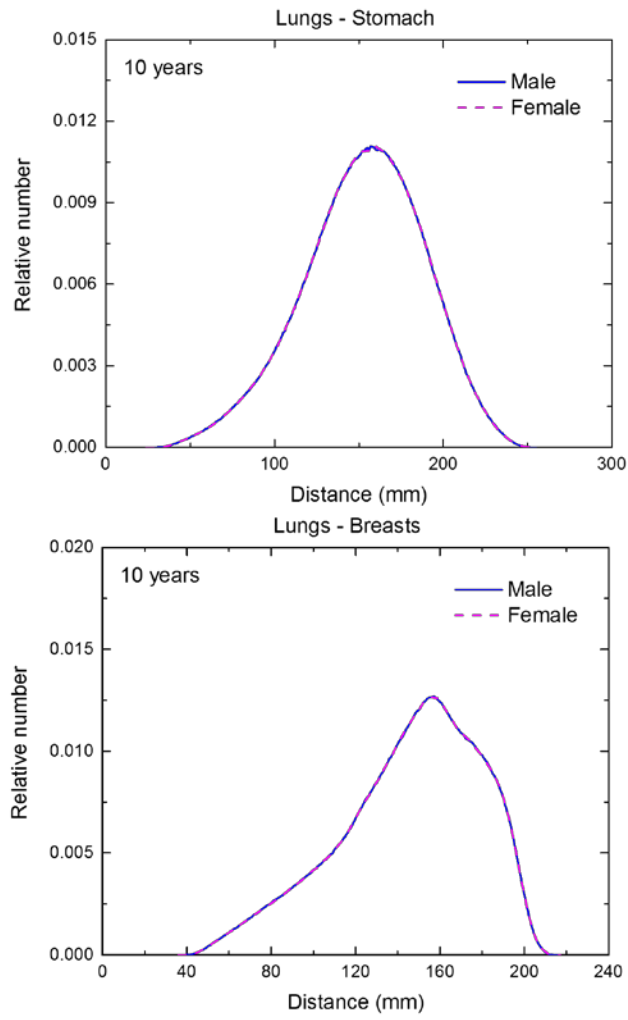
1395
 1396 Fig. F.14. Distribution of distances between 10 million randomly sampled point pairs in *liver*
 1397 (source region) and red bone marrow, colon, lungs, stomach wall, and breast (target regions) in
 1398 the *10-year-old male/female phantoms*.



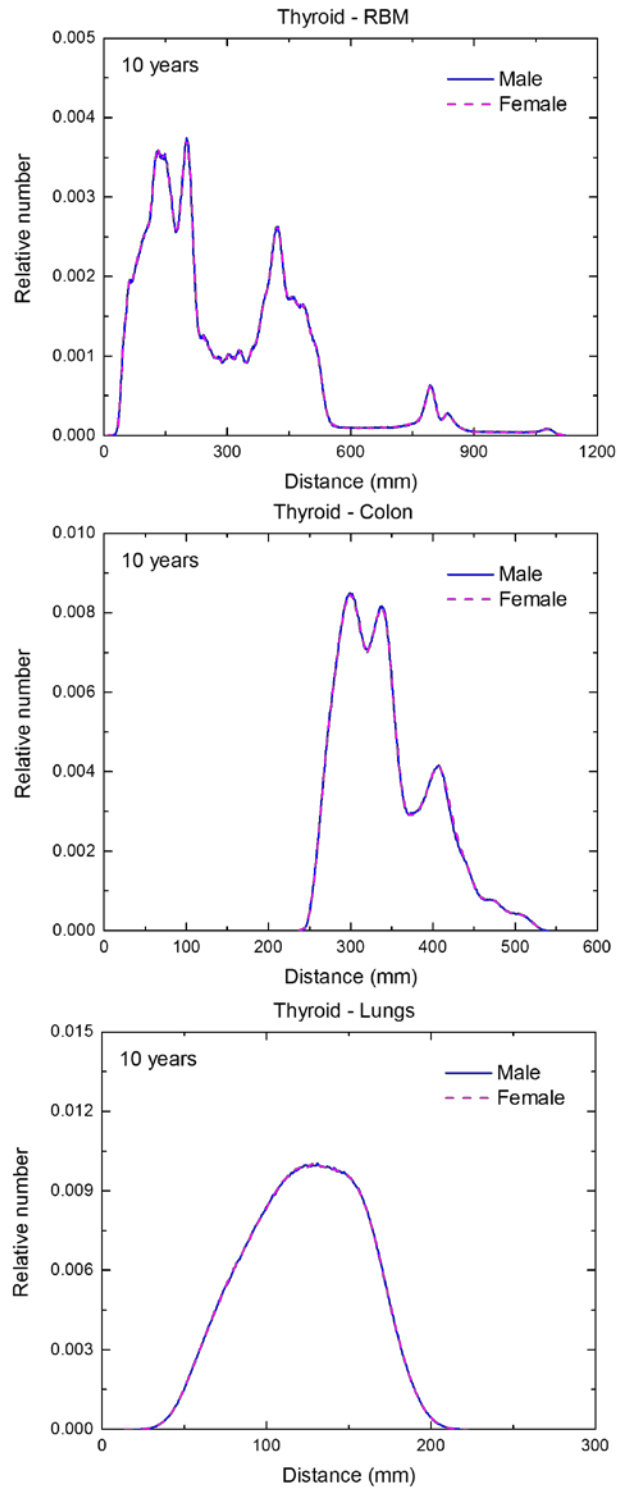
1399
1400 Fig. F.14. (continued)



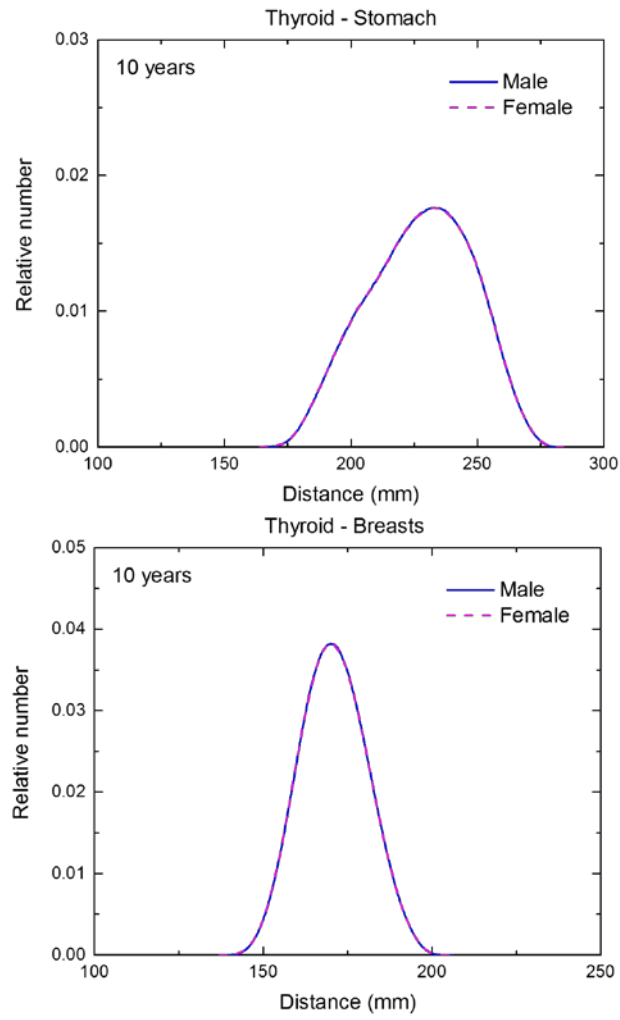
1401
 1402 Fig. F.15. Distribution of distances between 10 million randomly sampled point pairs in *lungs*
 1403 (source region) and red bone marrow, colon, lungs, stomach wall, and breast (target regions) in
 1404 the *10-year-old male/female phantoms*.



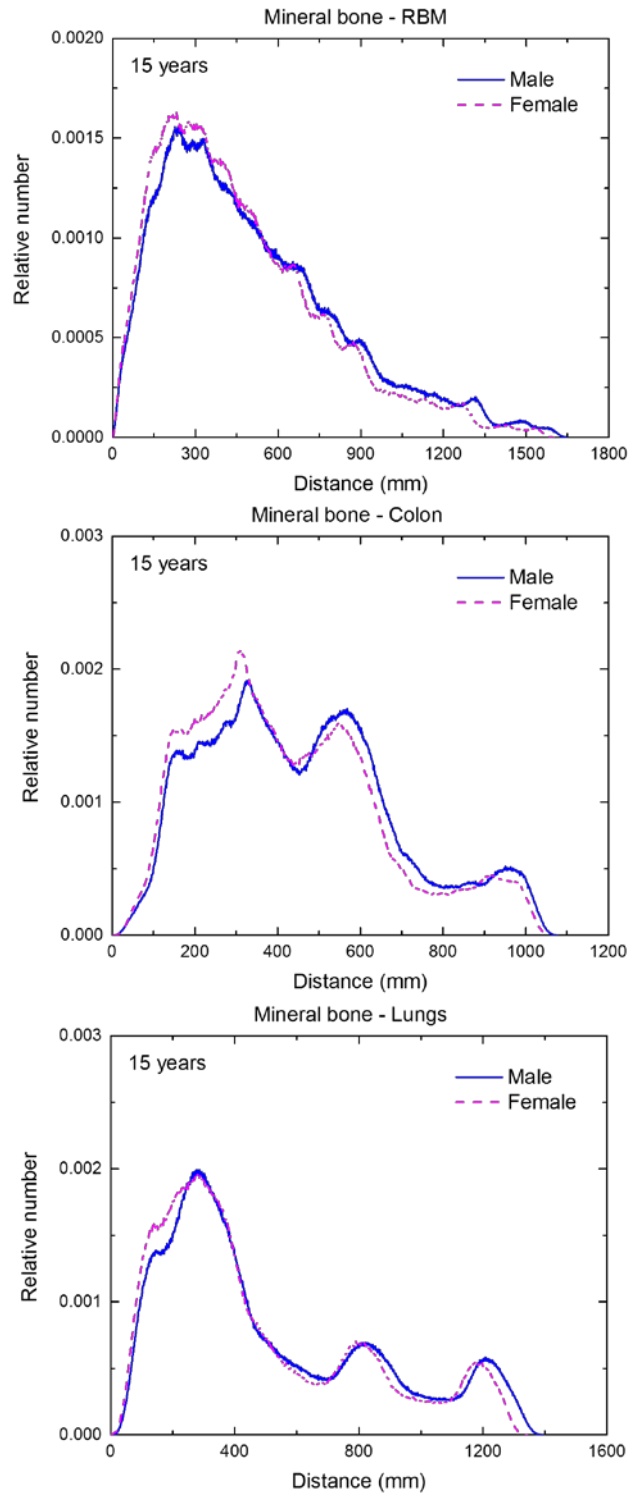
1405
1406 Fig. F.15. (continued)



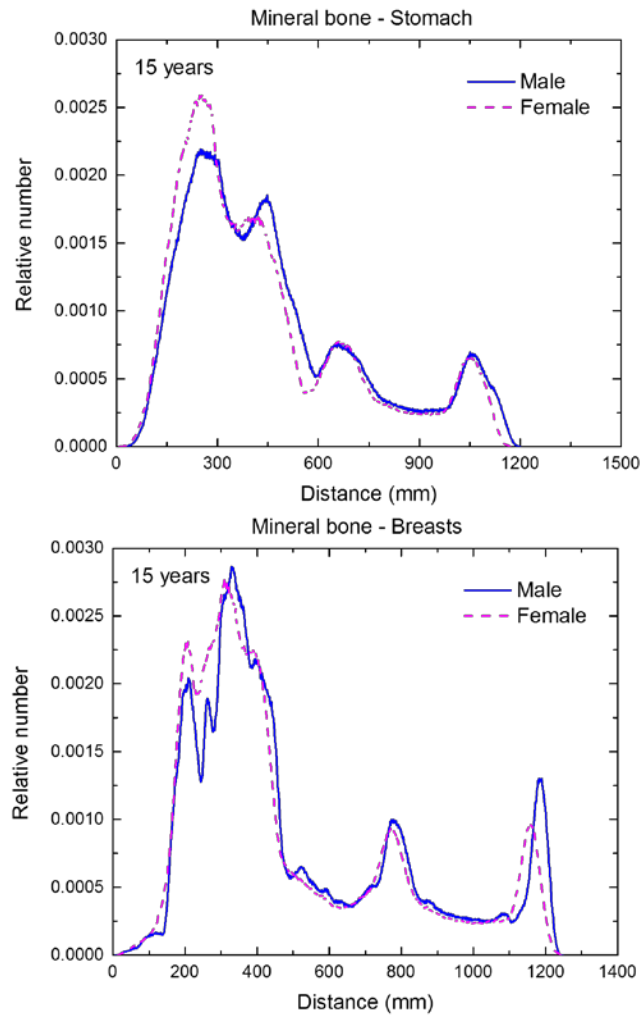
1407
 1408 Fig. F.16. Distribution of distances between 10 million randomly sampled point pairs in *thyroid*
 1409 (source region) and red bone marrow, colon, lungs, stomach wall, and breast (target regions) in
 1410 the *10-year-old male/female phantoms*.



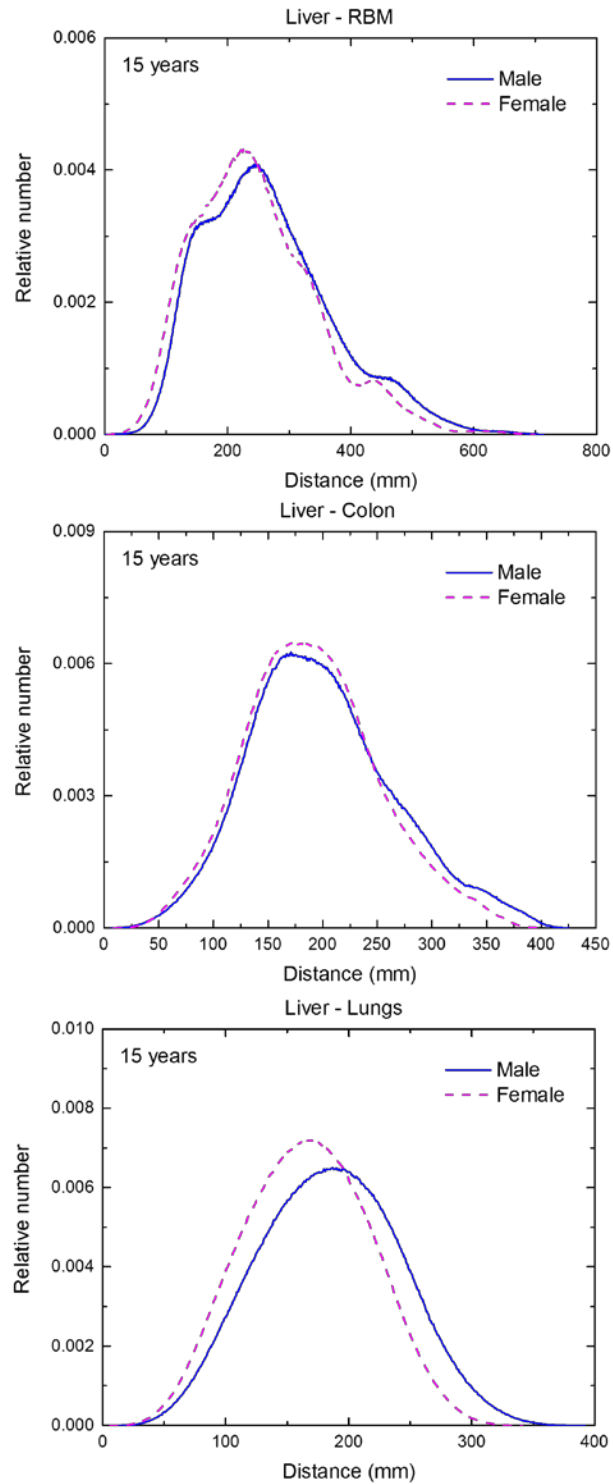
1411
1412 Fig. F.16. (continued)
1413



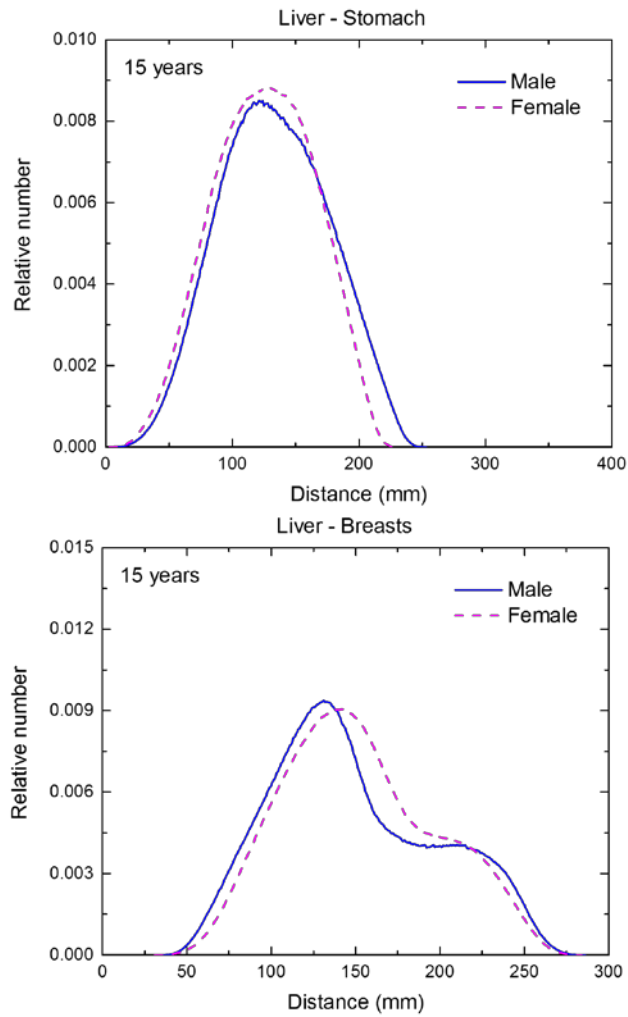
1414
 1415 Fig. F.17. Distribution of distances between 10 million randomly sampled point pairs in *mineral*
 1416 *bone* (source region) and red bone marrow, colon, lungs, stomach wall, and breast (target regions)
 1417 in the *15-year-old male/female phantoms*.



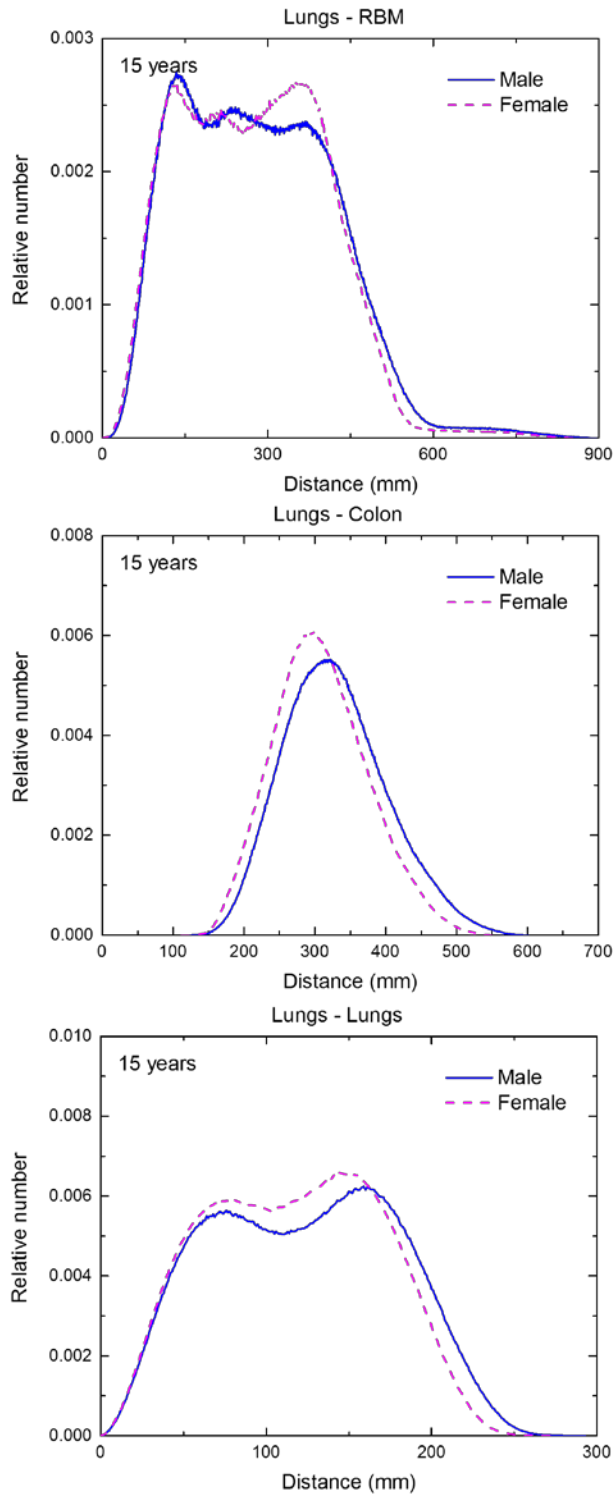
1418
1419 Fig. F.17. (continued)



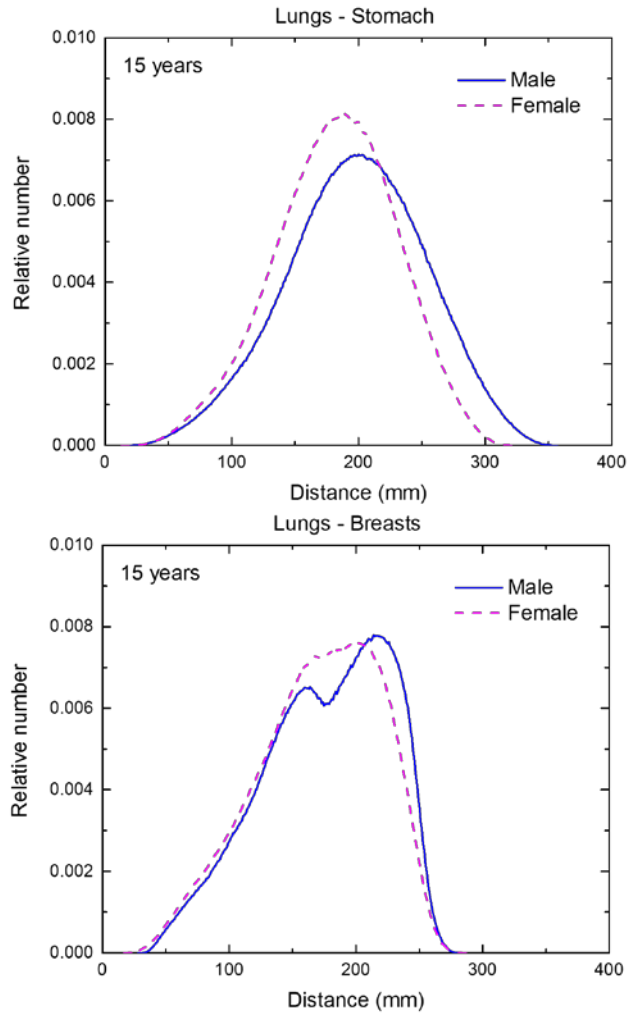
1420
 1421 Fig. F.18. Distribution of distances between 10 million randomly sampled point pairs in *liver*
 1422 (source region) and red bone marrow, colon, lungs, stomach wall, and breast (target regions) in
 1423 the *15-year-old male/female phantoms*.



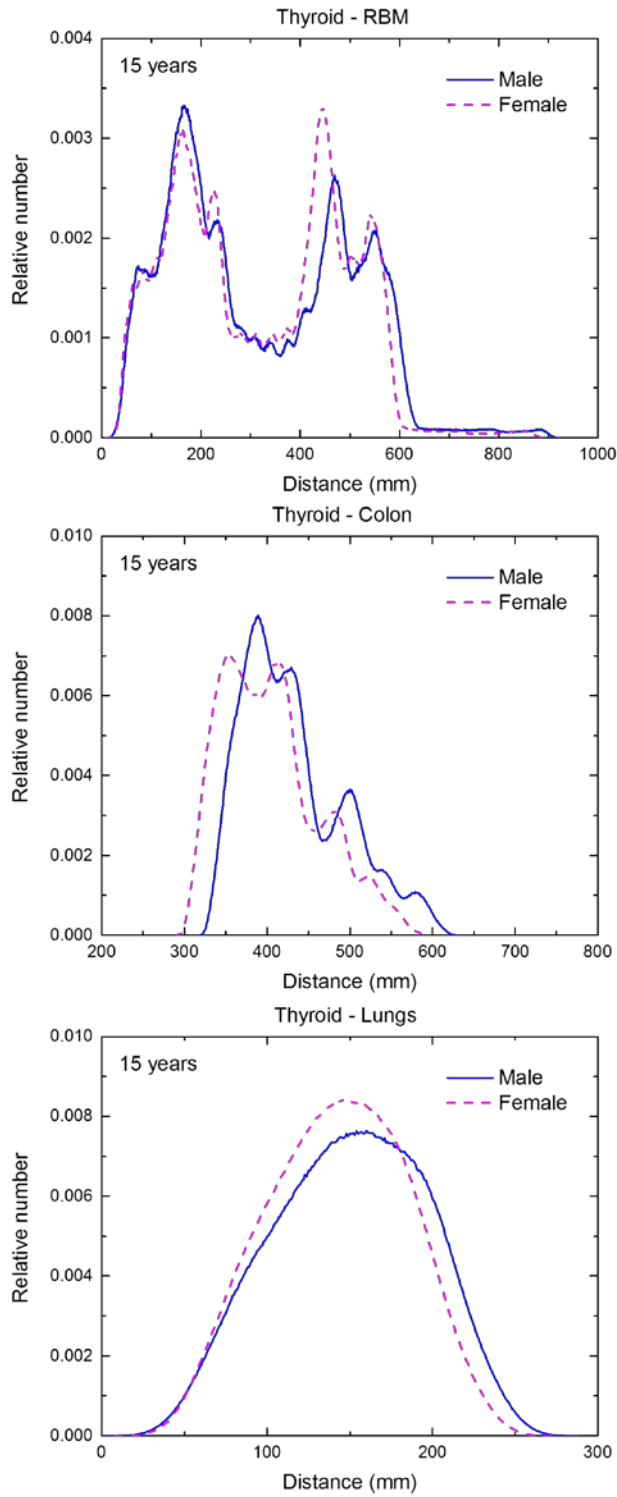
1424
1425 Fig. F.18. (continued)



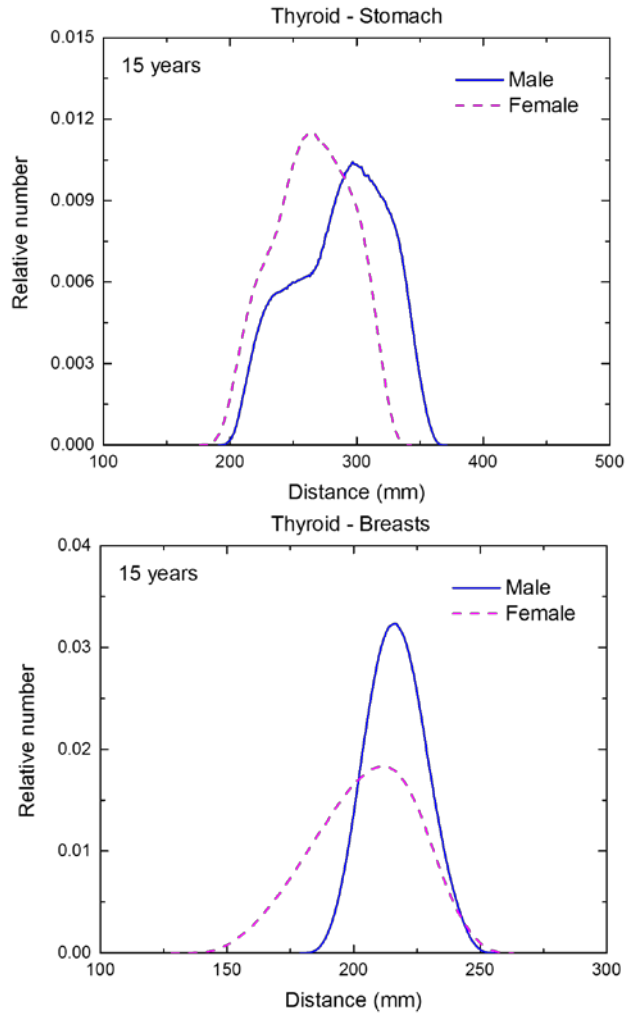
1426
 1427 Fig. F.19. Distribution of distances between 10 million randomly sampled point pairs in *lungs*
 1428 (source region) and red bone marrow, colon, lungs, stomach wall, and breast (target regions) in
 1429 the *15-year-old male/female phantoms*.



1430
1431 Fig. F.19. (continued)



1432
 1433 Fig. F.20. Distribution of distances between 10 million randomly sampled point pairs in *thyroid*
 1434 (source region) and red bone marrow, colon, lungs, stomach wall, and breast (target regions) in
 1435 the *15-year-old male/female phantoms*.



1436
1437 Fig. F.20. (continued)
1438

1439

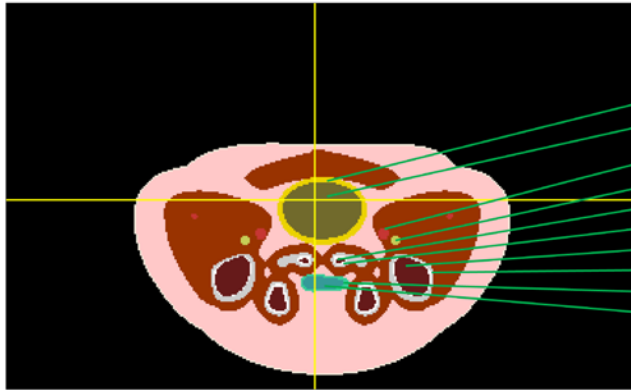
1440 **ANNEX G. CROSS-SECTIONAL VIEWS FOR SELECTED PHANTOMS**
1441 **AND BODY REGIONS**

1442 (G 1) This annex presents selected cross-sectional images of the paediatric reference
1443 computational phantoms. The cross-sectional images are presented in three different orientations,
1444 i.e. transverse, coronal, and sagittal. Each cross-sectional image presents a planar ‘cut’ through the
1445 three-dimensional voxel array describing the computational phantom. The transverse images show
1446 the columns (x co-ordinates) and rows (y co-ordinates) at a specific slice (z co-ordinate); the
1447 coronal images show the columns and slices at a specific row; and the sagittal images show the
1448 rows and slices at a specific column.

1449 (G 2) The green lines indicate the location of single organs as given in the legend. The yellow
1450 lines (appearing as a coordinate cross in the figures) indicate the location of the images in the other
1451 orientations. In the transversal images, the vertical yellow line indicates the location of the sagittal
1452 image, and the horizontal yellow line indicates the location of the coronal image.
1453

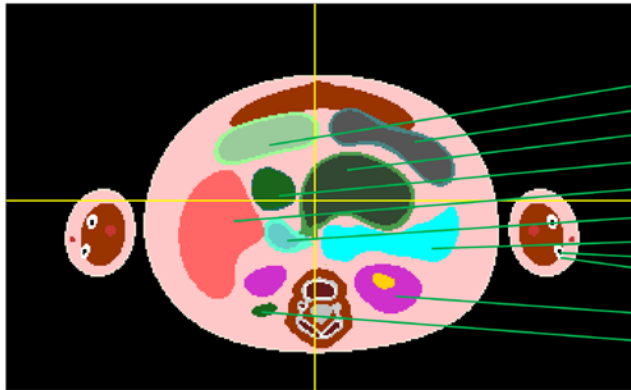
1454

Slice no. 241



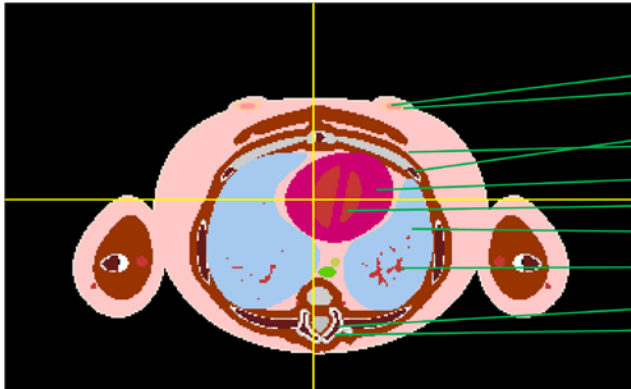
- Urinary bladder, wall
- Urinary bladder, contents (urine)
- Blood, legs
- Lymphatic nodes, trunk
- Pelvis, spongiosa
- Pelvis, cortical
- Femora, upper half, spongiosa
- Femora, upper half, cortical
- Sigmoid colon, wall
- Sigmoid colon, contents

Slice no. 363



- Transverse colon, left
- Transverse colon, right
- Stomach
- Gall bladder
- Liver
- Small intestine
- Pancreas
- Ulnae and radii, medullary cavity
- Ulnae and radii, cortical
- Kidneys
- Adrenal

Slice no. 452



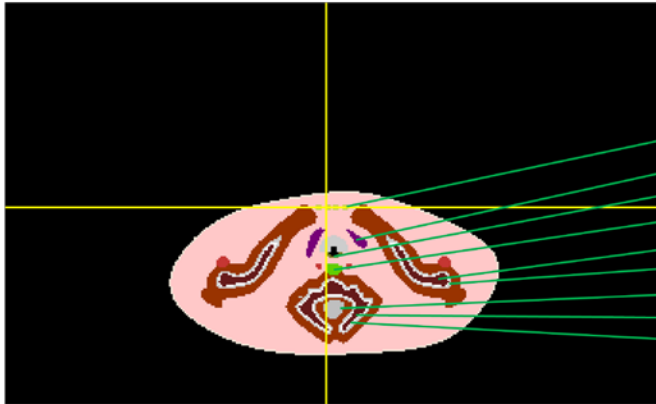
- Breast, glandular tissue
- Breast, adipose tissue
- Ribs, spongiosa
- Ribs, cortex
- Heart, wall
- Heart, contents (blood)
- Lung, tissue
- Lung, blood
- Thoracic spine, spongiosa
- Thoracic spine, cortical

1455

1456

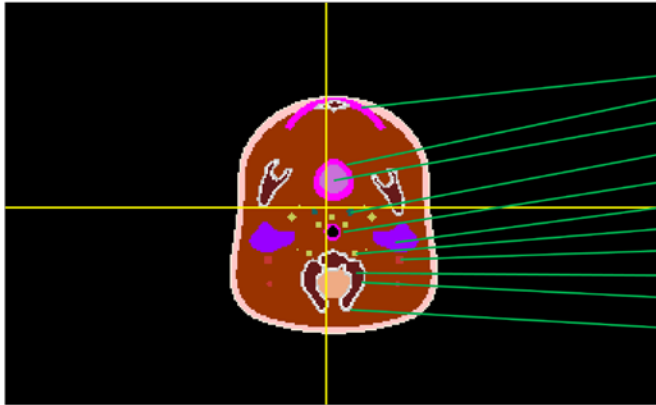
Fig. G.1. Transverse (axial) images of the *newborn male phantom*.

Slice no. 533



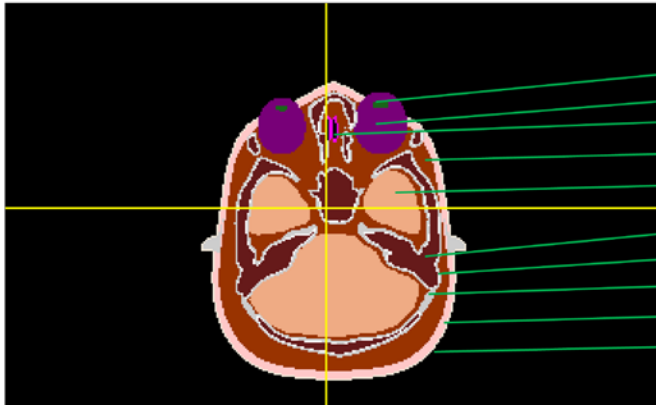
- Lymphatic nodes, ET airways
- Thyroid
- Trachea
- Oesophagus
- Clavicles, spongiosa
- Clavicles, cortical
- Spinal cord
- Cervical spine, spongiosa
- Cervical spine, cortical

Slice no. 570



- Oral mucosa
- Tongue
- Tonsils
- ET2
- Salivary glands
- Lymphatic nodes, ET airways
- Blood, head
- Cervical spine, spongiosa
- Cervical spine, cortical
- Cartilage, trunk

Slice no. 608



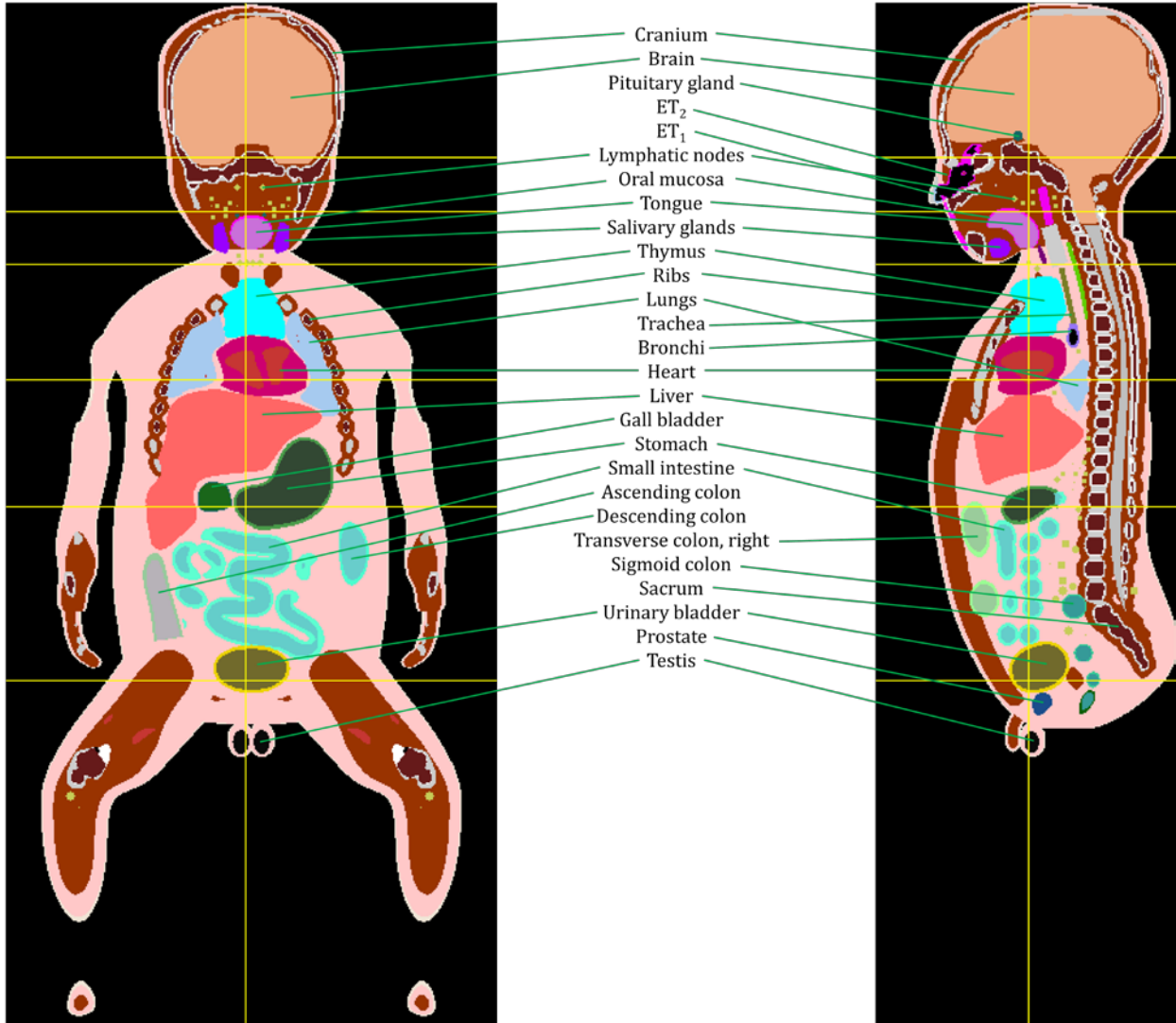
- Eye lens
- Eye bulb
- ET₂
- Muscle, head
- Brain
- Cranium, spongiosa
- Cranium, cortical
- Cartilage, head
- Residual tissue, head
- Skin, head

1457
1458
1459

Fig. G.1. (continued)

Row no. 108

Column no. 169

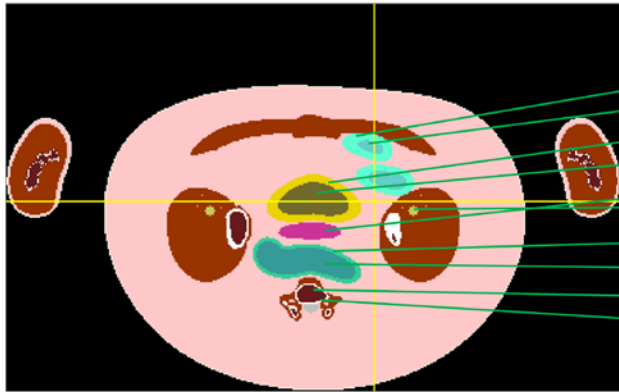


1460

1461

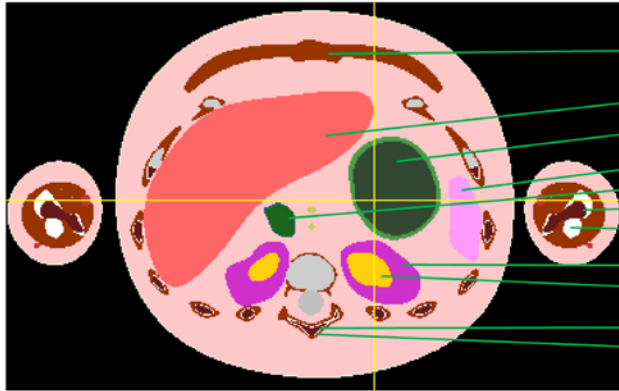
Fig. G.2. Coronal and sagittal images of the *newborn male phantom*.

Slice no. 234



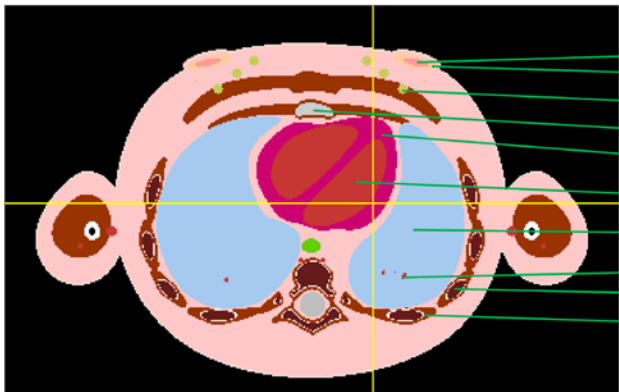
- Small intestine, wall
- Small intestine, contents
- Urinary bladder, wall
- Urinary bladder, contents (urine)
- Uterus
- Lymphatic nodes, trunk
- Sigmoid colon, wall
- Sigmoid colon, contents
- Sacrum, spongiosa
- Sacrum, cortical

Slice no. 319



- Muscle, trunk
- Liver
- Stomach
- Spleen
- Gall bladder
- Humeri, lower half, spongiosa
- Ulnae and radii, cortical
- Kidney, cortex
- Kidney, medulla
- Thoracic spine, spongiosa
- Thoracic spine, cortical

Slice no. 360

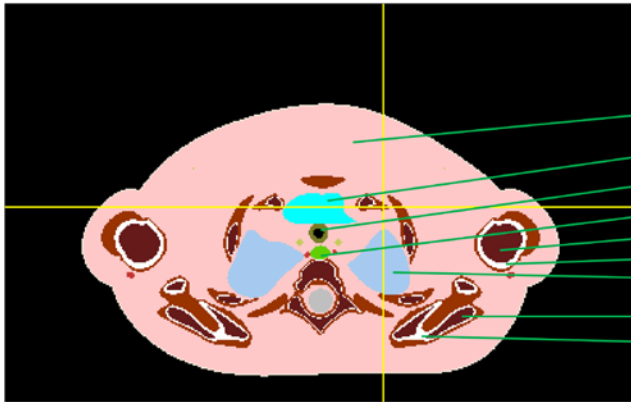


- Breast, glandular tissue
- Breast, adipose tissue
- Lymphatic node, trunk
- Cartilage, trunk
- Heart, wall
- Heart, contents (blood)
- Lung, tissue
- Lung, blood
- Ribs, spongiosa
- Ribs, cortical

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1463

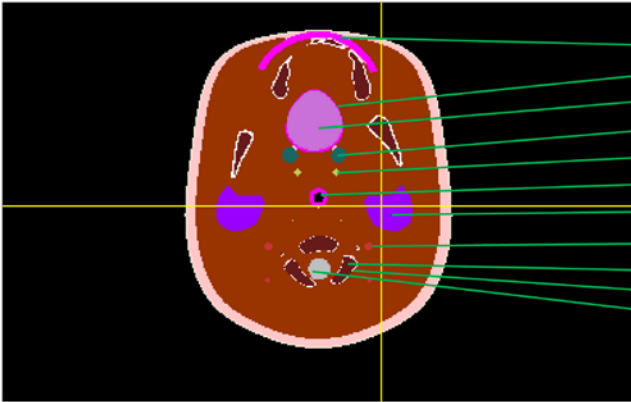
Fig. G.3. Transverse (axial) images of the *1-year-old female phantom*.

Slice no. 405



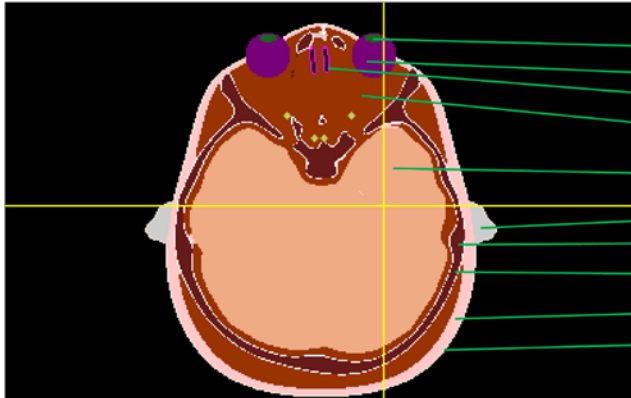
- Residual tissue, trunk
- Thymus
- Trachea
- Oesophagus
- Humeri, upper half, spongiosa
- Humeri, upper half, cortical
- Lung
- Scapulae, spongiosa
- Scapulae, cortical

Slice no. 449



- Oral mucosa
- Tongue
- Tonsils
- Lymphatic nodes, ET airways
- ET₂
- Salivary glands
- Blood, head
- Cervical spine, spongiosa
- Cervical spine, cortical
- Spinal cord

Slice no. 477



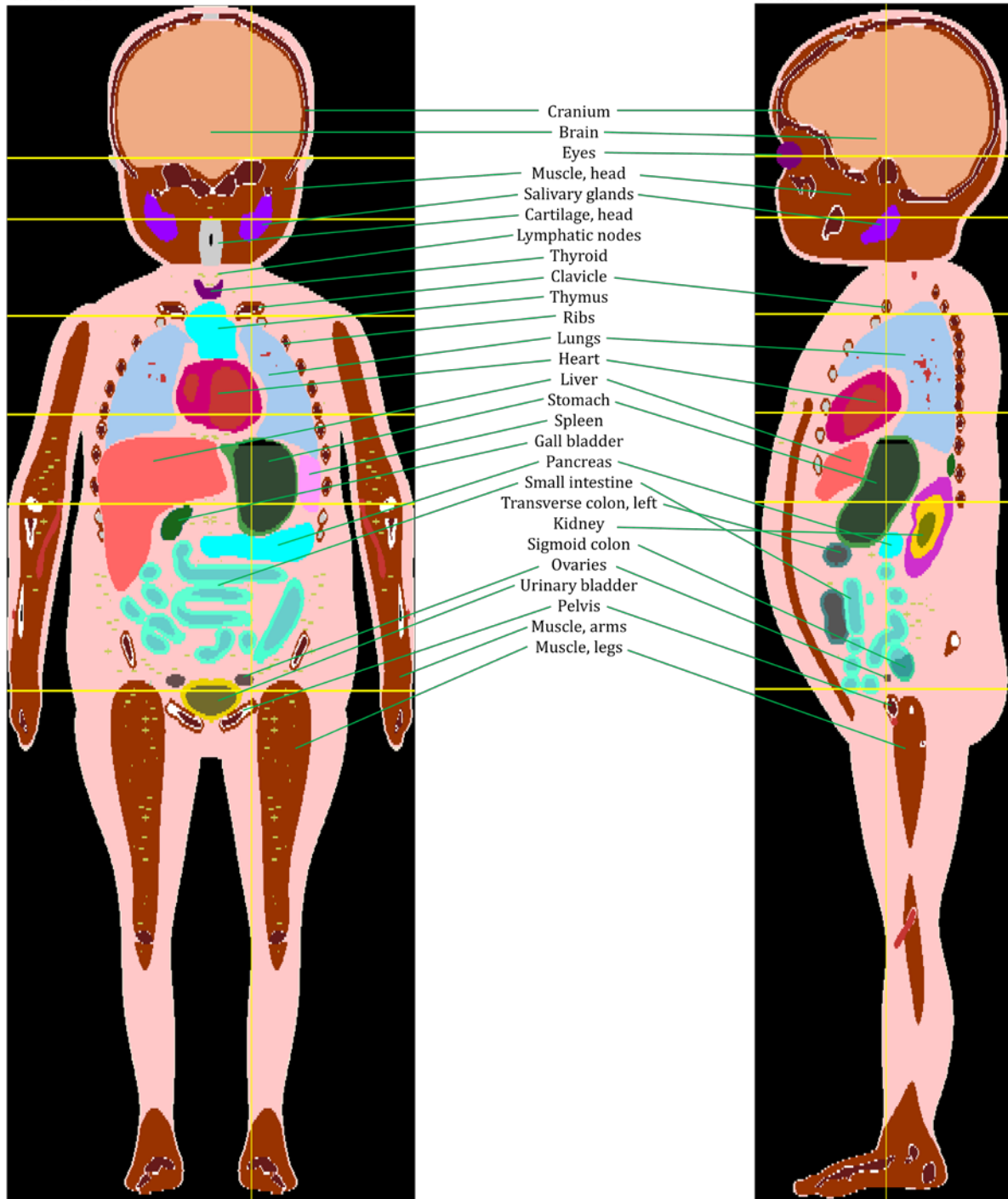
- Eye lens
- Eye bulb
- ET₂
- Muscle, head
- Brain
- Cartilage, head
- Cranium, spongiosa
- Cranium, cortical
- Residual tissue, head
- Skin, head

1464
1465
1466

Fig. G.3. (continued)

Row no. 127

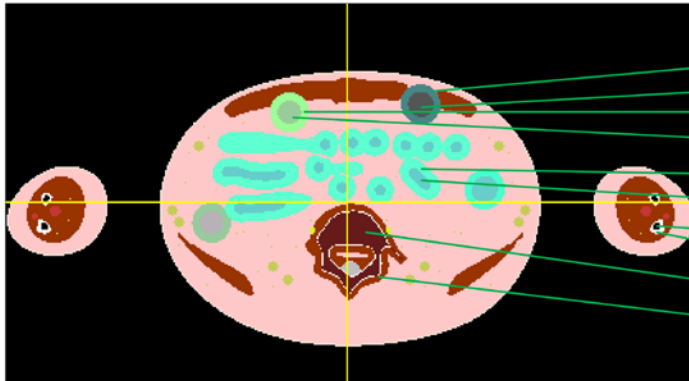
Column no. 236



1467
1468

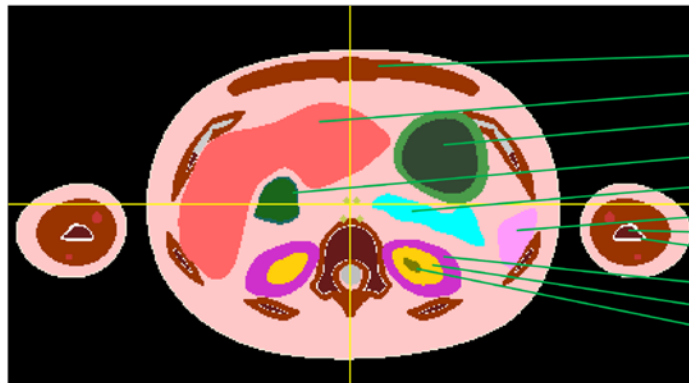
Fig. G.4. Coronal and sagittal images of the *1-year-old female phantom*.

Slice no. 320



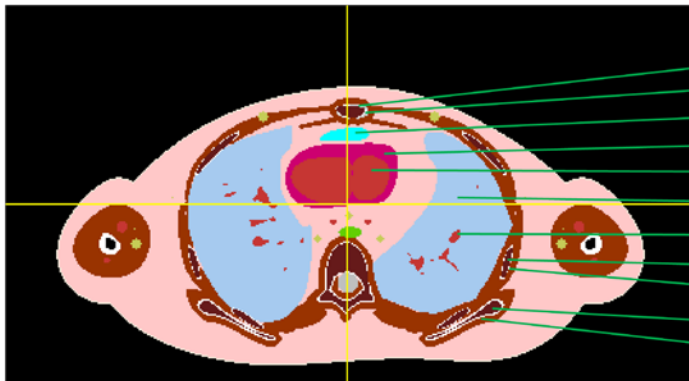
- Transverse colon left, wall
- Transverse colon left, contents
- Transverse colon right, wall
- Transverse colon right, contents
- Small intestine, wall
- Small intestine, contents
- Ulnae and radii, medullary cavity
- Ulnae and radii, cortical
- Lumbar spine, spongiosa
- Lumbar spine, cortical

Slice no. 363



- Muscle, trunk
- Liver
- Stomach
- Gall bladder
- Pancreas
- Spleen
- Humeri, lower half, spongiosa
- Humeri, lower half, cortical
- Kidney, cortex
- Kidney, medulla
- Kidney, pelvis

Slice no. 425

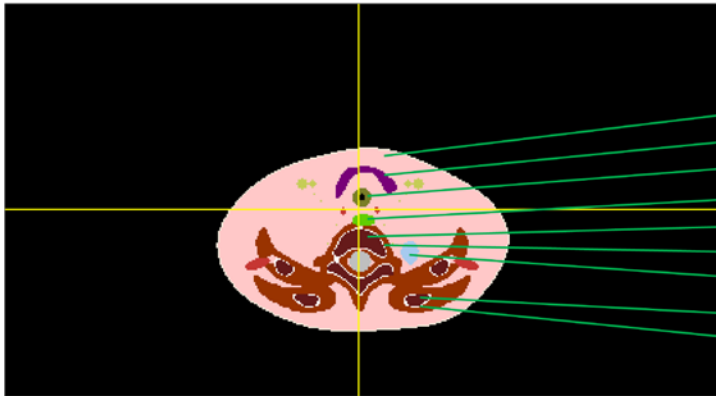


- Sternum, spongiosa
- Sternum, cortical
- Thymus
- Heart, wall
- Heart, contents (blood)
- Lung, tissue
- Lung, blood
- Ribs, spongiosa
- Ribs, cortical
- Scapulae, spongiosa
- Scapulae, cortical

1469
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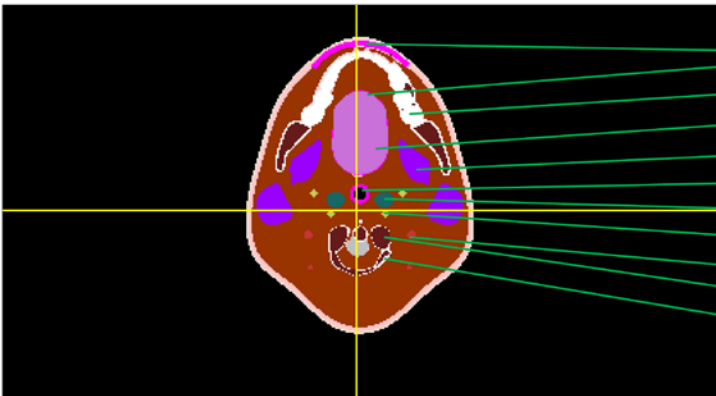
Fig. G.5. Transverse (axial) images of the *5-year-old male phantom*.

Slice no. 460



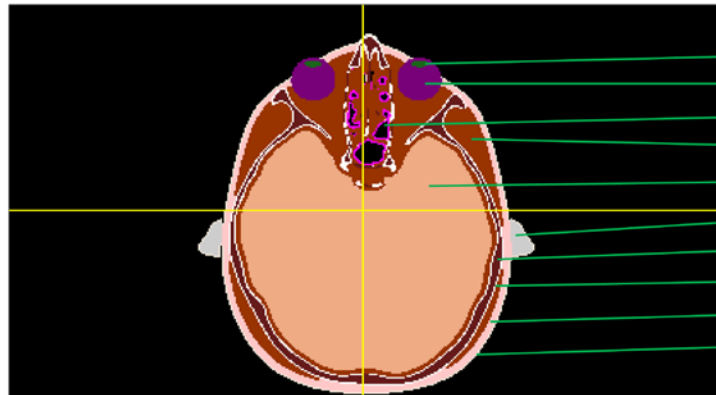
- Residual tissue, trunk
- Thyroid
- Trachea
- Oesophagus
- Thoracic spine, spongiosa
- Thoracic spine, cortical
- Lung
- Ribs, spongiosa
- Ribs, cortical

Slice no. 490



- Oral mucosa
- Teeth
- Tongue
- Salivary glands
- ET₂
- Tonsils
- Lymphatic nodes, ET airways
- Blood, head
- Cervical spine, spongiosa
- Cervical spine, cortical

Slice no. 518

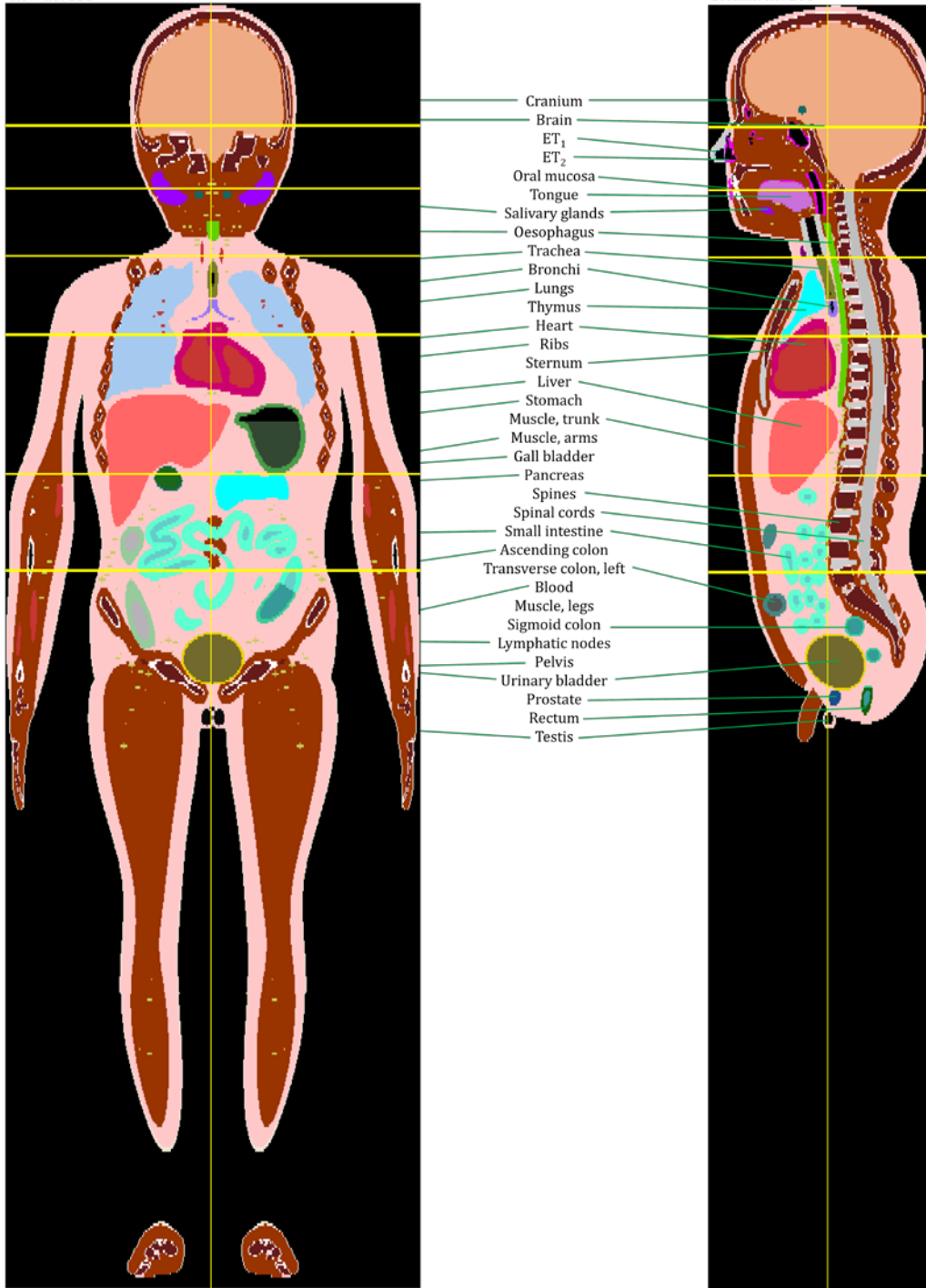


- Eye lens
- Eye bulb
- ET₂
- Muscle, head
- Brain
- Cartilage, head
- Cranium, spongiosa
- Cranium, cortical
- Residual tissue, head
- Skin, head

1471
 1472 Fig. G.5. (continued)
 1473

Row no. 121

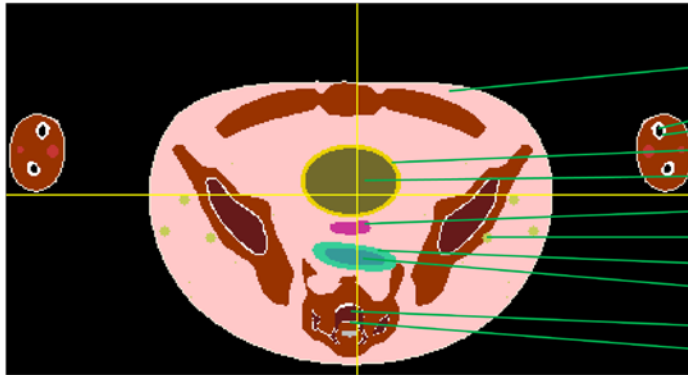
Column no. 208



1474
1475

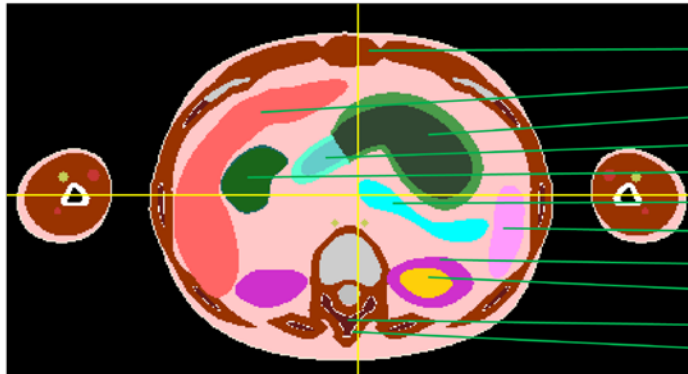
Fig. G.6. Coronal and sagittal images of the *5-year-old male phantom*.

Slice no. 304



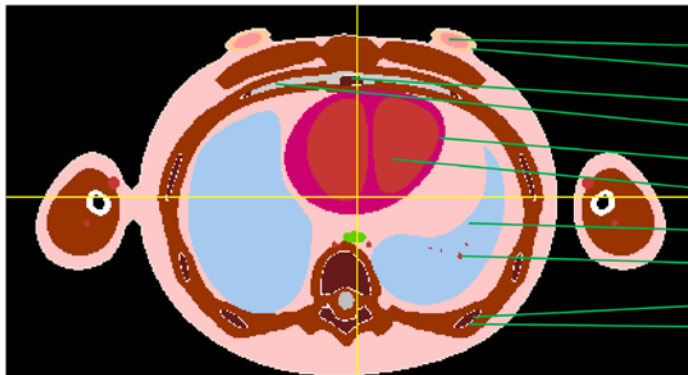
- Residual tissue, trunk
- Ulnae and radii, medullary cavity
- Ulnae and radii, cortical
- Urinary bladder, wall
- Urinary bladder, contents (urine)
- Uterus
- Lymphatic nodes, trunk
- Sigmoid colon, wall
- Sigmoid colon, contents
- Sacrum, spongiosa
- Sacrum, cortical

Slice no. 388



- Muscle, trunk
- Liver
- Stomach
- Small intestine
- Gall bladder
- Pancreas
- Spleen
- Kidney, cortex
- Kidney, medulla
- Thoracic spine, spongiosa
- Thoracic spine, cortical

Slice no. 426

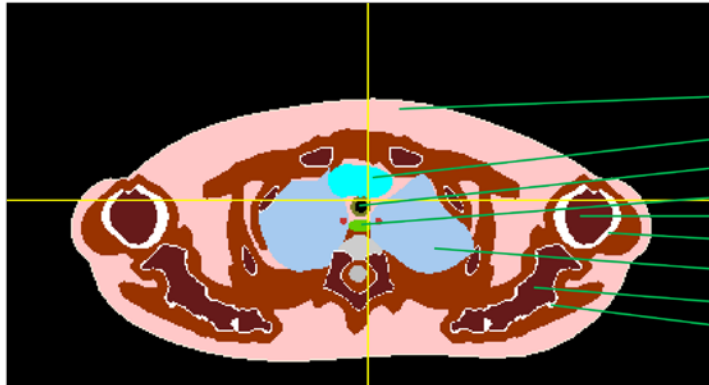


- Breast, glandular tissue
- Breast, adipose tissue
- Sternum, spongiosa
- Cartilage, trunk
- Heart, wall
- Heart, contents (blood)
- Lung, tissue
- Lung, blood
- Ribs, spongiosa
- Ribs, cortical

1476
1477

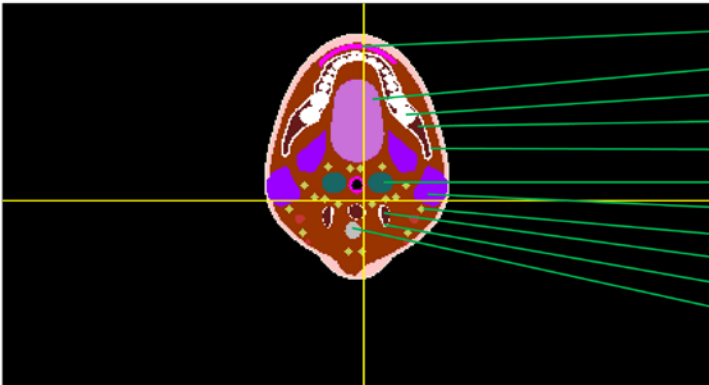
Fig. G.7. Transverse (axial) images of the *10-year-old female phantom*.

Slice no. 469



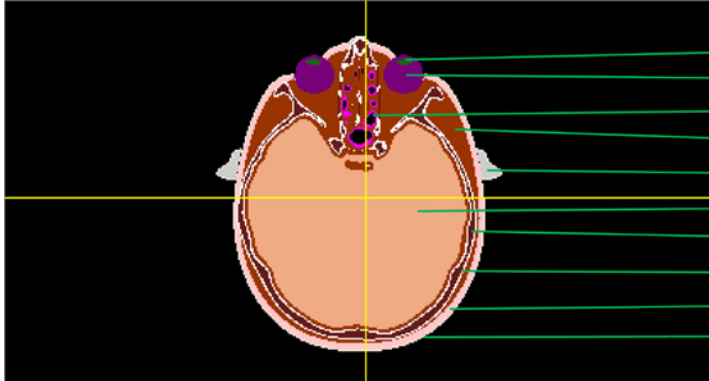
- Residual tissue, trunk
- Thymus
- Trachea
- Oesophagus
- Humeri, upper half, spongiosa
- Humeri, upper half, cortical
- Lung
- Scapulae, spongiosa
- Scapulae, cortical

Slice no. 508



- Oral mucosa
- Tongue
- Teeth
- Mandible, spongiosa
- Mandible, cortical
- Tonsils
- Salivary glands
- Lymphatic nodes, ET airways
- Cervical spine, spongiosa
- Cervical spine, cortical
- Spinal cord

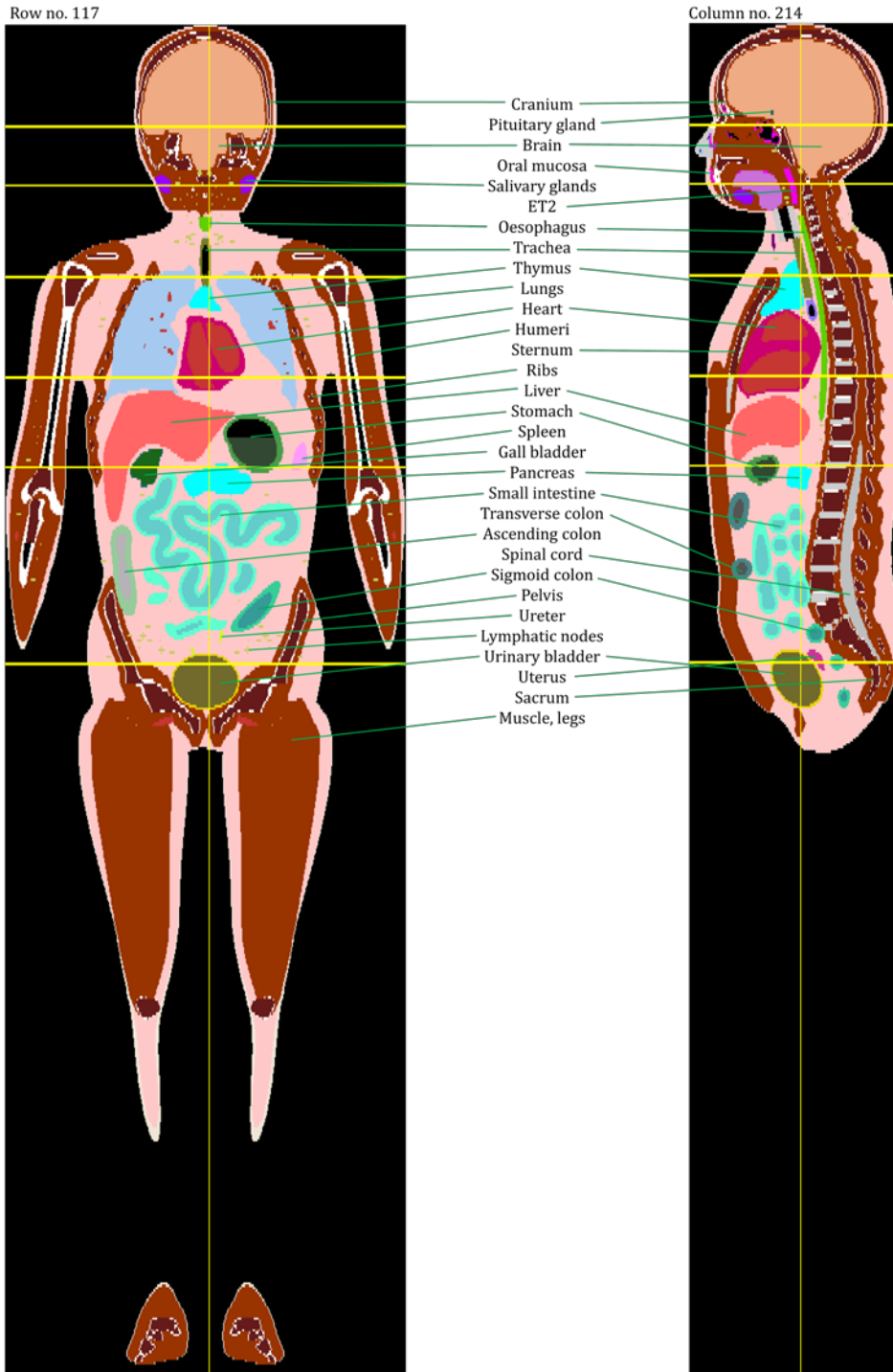
Slice no. 533



- Eye lens
- Eye bulb
- ET₂
- Muscle, head
- Cartilage, head
- Brain
- Cranium, spongiosa
- Cranium, cortical
- Residual tissue, head
- Skin, head

1478
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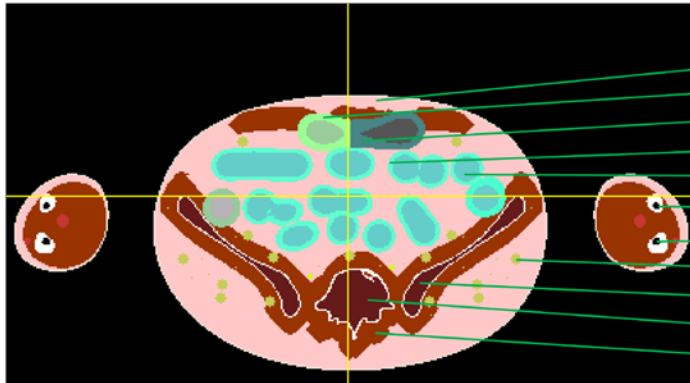
Fig. G.7. (continued)



1481
1482

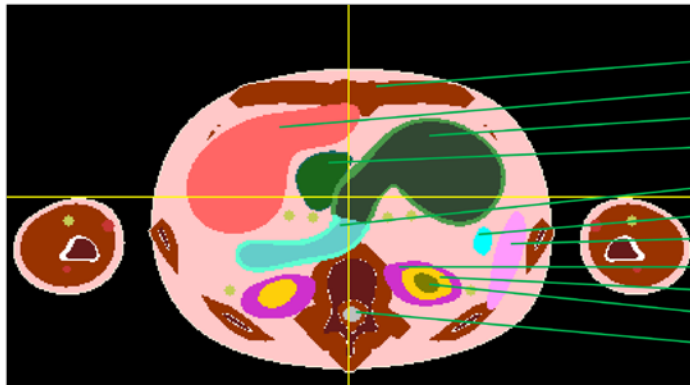
Fig. G.8. Coronal and sagittal images of the *10-year-old female phantom*.

Slice no. 346



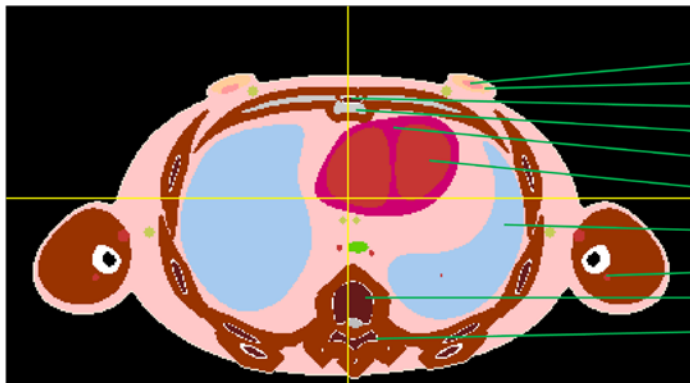
- Residual tissue, trunk
- Transverse colon right, wall
- Transverse colon left, wall
- Small intestine, wall
- Small intestine, contents
- Ulnae and radii, cortical
- Ulnae and radii, medullary cavity
- Lymphatic nodes, trunk
- Pelvis, spongiosa
- Sacrum, spongiosa
- Muscle, trunk

Slice no. 392



- Muscle, trunk
- Liver
- Stomach
- Gall bladder
- Small intestine
- Pancreas
- Spleen
- Kidney, cortex
- Kidney, medulla
- Kidney, pelvis
- Spinal cord

Slice no. 436

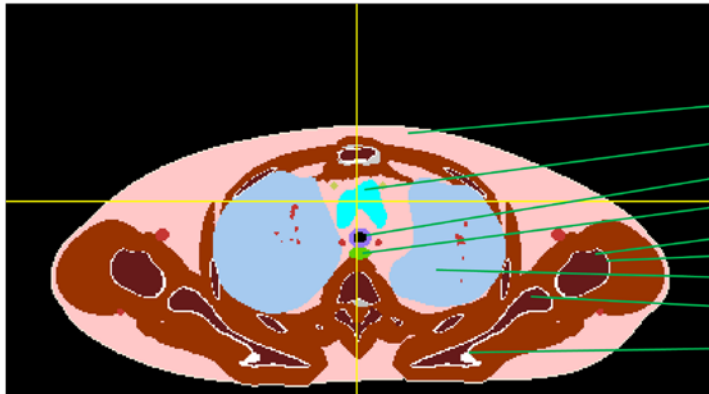


- Breast, glandular tissue
- Breast, adipose tissue
- Sternum, spongiosa
- Cartilage, trunk
- Heart, wall
- Heart, contents (blood)
- Lung, tissue
- Blood, arms
- Thoracic spine, spongiosa
- Thoracic spine, cortical

1483
1484

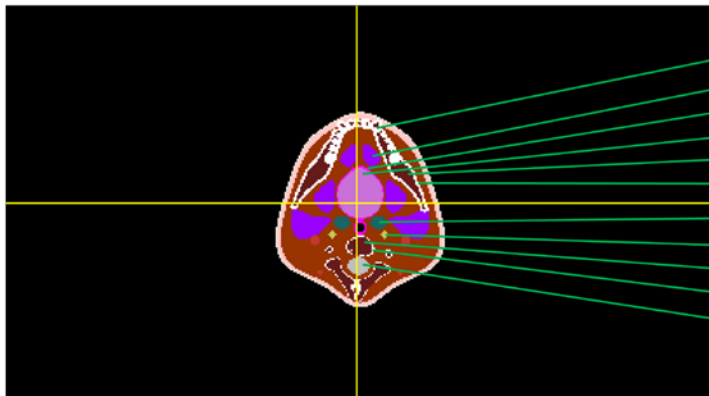
Fig. G.9. Transverse (axial) images of the *15-year-old male phantom*.

Slice no. 473



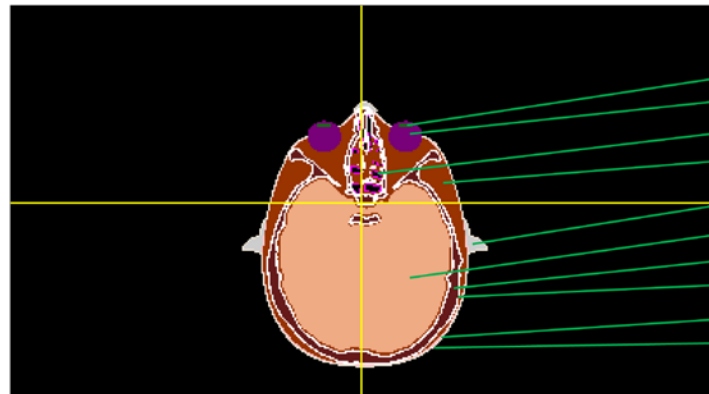
- Residual tissue, trunk
- Thymus
- Bronchi
- Oesophagus
- Humeri, upper half, spongiosa
- Humeri, upper half, cortical
- Lung
- Scapulae, spongiosa
- Scapulae, cortical

Slice no. 523



- Teeth
- Salivary glands
- Oral mucosa
- Tongue
- Mandible, spongiosa
- Mandible, cortical
- Tonsils
- Lymphatic nodes, ET airways
- Cervical spine, spongiosa
- Cervical spine, cortical
- Spinal cord

Slice no. 549



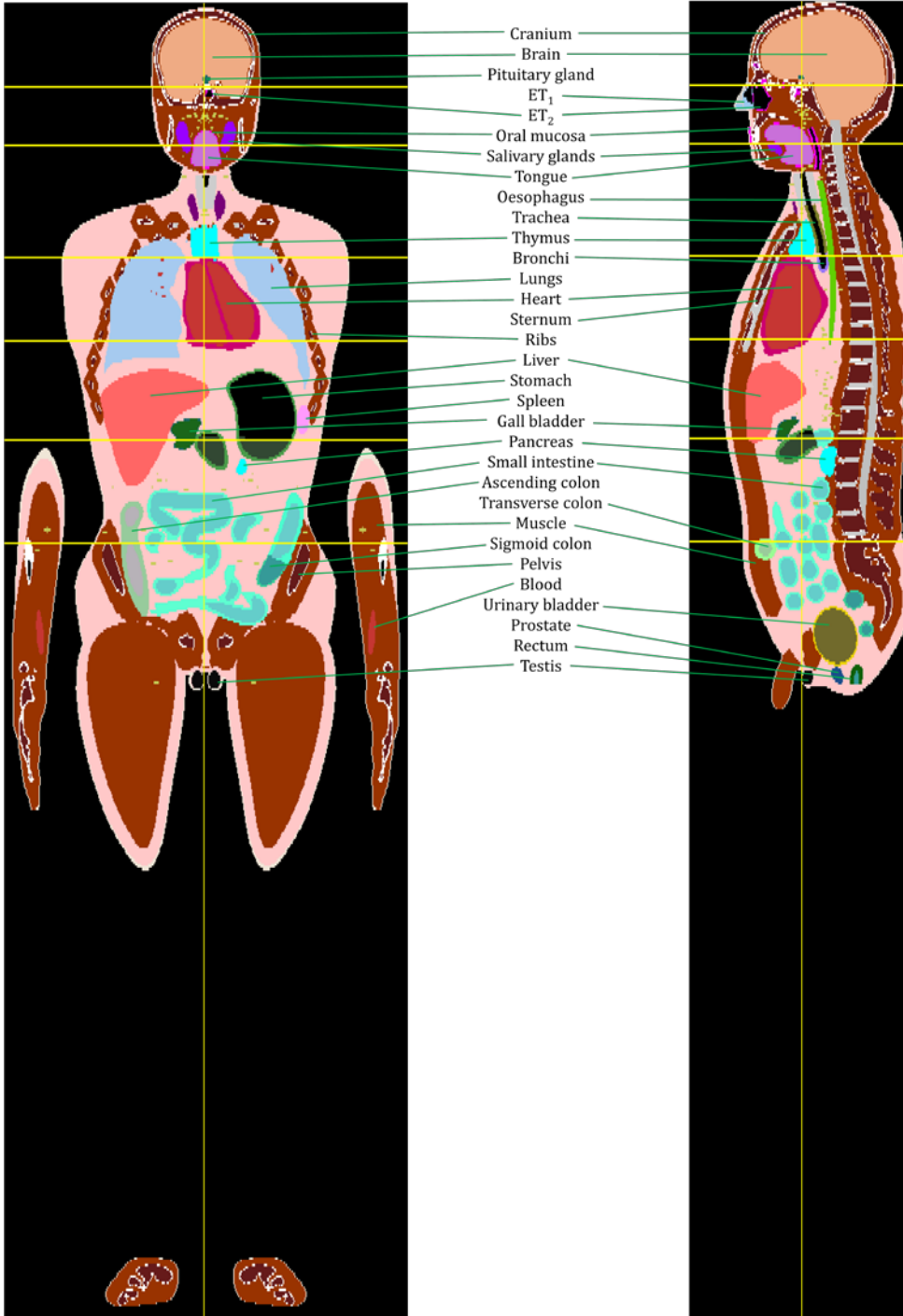
- Eye lens
- Eye bulb
- ET₂
- Muscle, head
- Cartilage, head
- Brain
- Cranium, spongiosa
- Cranium, cortical
- Residual tissue, head
- Skin, head

1485
1486

Fig. G.9. (continued)

Row no. 114

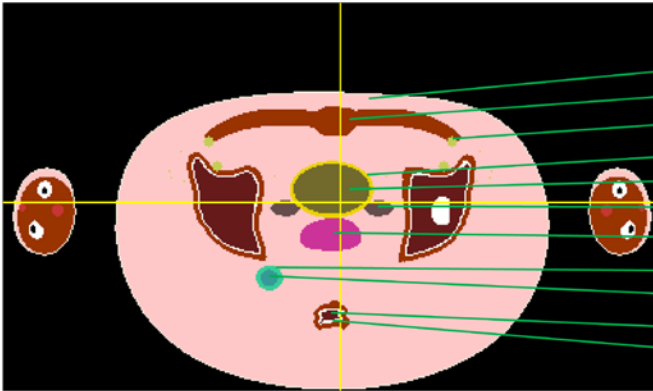
Column no. 202



1487
1488

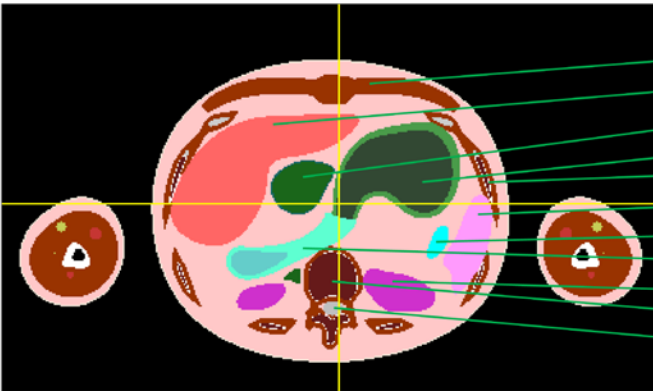
Fig. G.10. Coronal and sagittal images of the *15-year-old male phantom*.

Slice no. 305



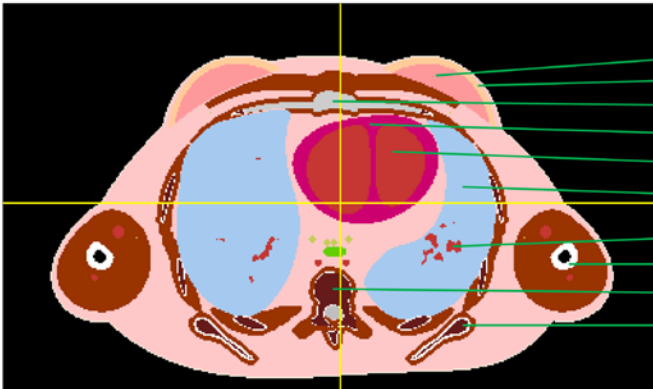
- Residual tissue, trunk
- Muscle, trunk
- Lymphatic nodes, trunk
- Urinary bladder, wall
- Urinary bladder, contents (urine)
- Ovaries
- Uterus
- Sigmoid colon, wall
- Sigmoid colon, contents
- Sacrum, spongiosa
- Sacrum, cortical

Slice no. 389



- Liver
- Stomach
- Gall bladder
- Small intestine
- Ribs, spongiosa
- Spleen
- Pancreas
- Small intestine
- Kidney, cortex
- Lumbar spine, spongiosa
- Spinal cord

Slice no. 432

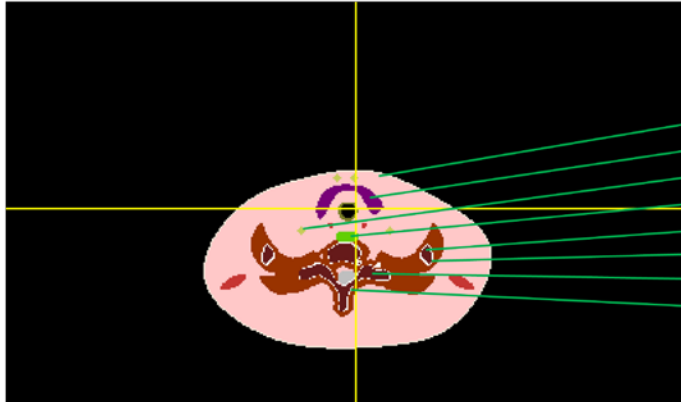


- Breast, glandular tissue
- Breast, adipose tissue
- Cartilage, trunk
- Heart, wall
- Heart, contents (blood)
- Lung, tissue
- Lung, blood
- Humeri, upper half, cortical
- Thoracic spine, spongiosa
- Scapulae, spongiosa

1489
1490

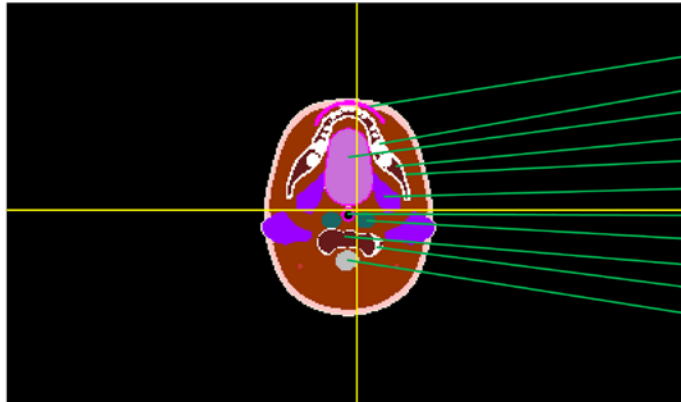
Fig. G.11. Transverse (axial) images of the *15-year-old female phantom*.

Slice no. 481



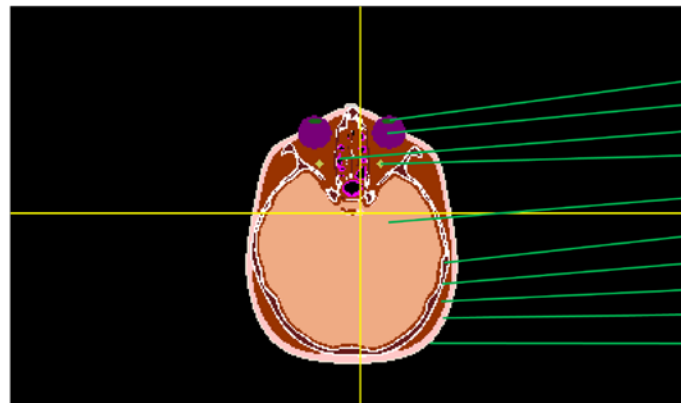
- Residual tissue, trunk
- Thyroid
- Lymphatic nodes, ET airways
- Oesophagus
- Ribs, spongiosa
- Ribs, cortical
- Thoracic spine, spongiosa
- Thoracic spine, cortical

Slice no. 512



- Oral mucosa
- Teeth
- Tongue
- Mandible, spongiosa
- Mandible, cortical
- Salivary glands
- ET₂
- Tonsils
- Cervical spine, spongiosa
- Cervical spine, cortical
- Spinal cord

Slice no. 534

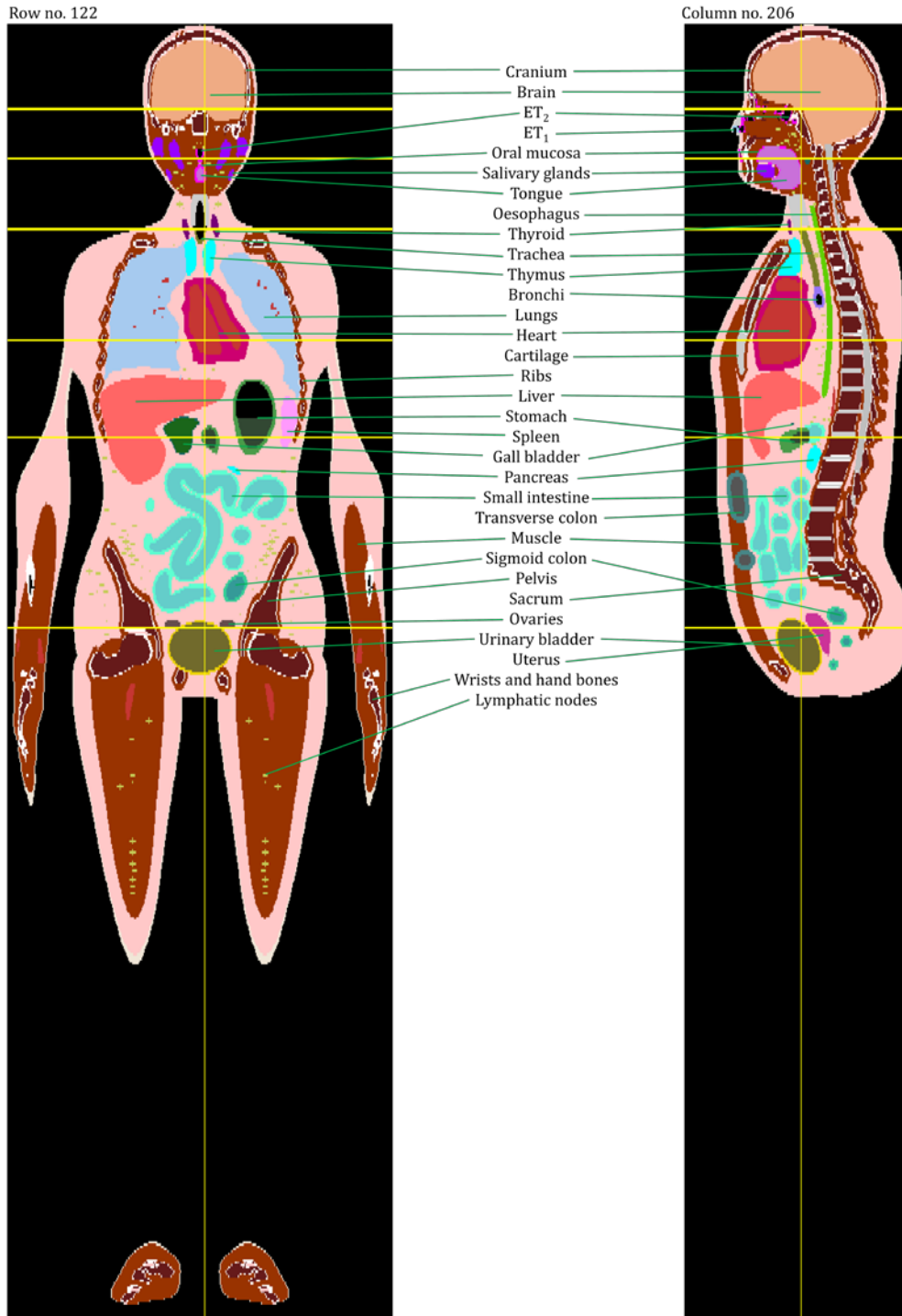


- Eye lens
- Eye bulb
- ET₂
- Lymphatic nodes, ET airways
- Brain
- Cranium, spongiosa
- Cranium, cortical
- Muscle, head
- Residual tissue, head
- Skin, head

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1492

Fig. G.11. (Continued)



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Fig. G.12. Coronal and sagittal images of the *15-year-old female phantom*.

1496 **ANNEX H. DESCRIPTION OF THE ELECTRONIC FILES FOR THE**
 1497 **PEDIATRIC PHANTOMS**

1498 (H 1) The data files for the paediatric reference phantoms are available for download from
 1499 www.icrp.org. The data files are organized into ten main folders, one for each of the ten reference
 1500 phantoms (00M: newborn male, 00F: newborn female, 01M: 1-year-old male, 01F: 1-year-old
 1501 female, 05M: 5-year-old male, 05F: 5-year-old female, 10M: 10-year-old male, 10F: 10-year-old
 1502 female, 15M: 15-year-old male, 15F: 15-year-old female). Each folder contains the following files:

- 1503 • The array of organ ID numbers in ASCII format and binary format; the file names are:

ASCII format	Binary format
00M_ascii.dat	00M_binary.dat
00F_ascii.dat	00F_binary.dat
01M_ascii.dat	01M_binary.dat
01F_ascii.dat	01F_binary.dat
05M_ascii.dat	05M_binary.dat
05F_ascii.dat	05F_binary.dat
10M_ascii.dat	10M_binary.dat
10F_ascii.dat	10F_binary.dat
15M_ascii.dat	15M_binary.dat
15F_ascii.dat	15F_binary.dat

- 1506 • A list of individually segmented structures, their identification numbers, and assigned
 1507 media (Annex A); the file names are:

00M_organs.dat
00F_organs.dat
01M_organs.dat
01F_organs.dat
05M_organs.dat
05F_organs.dat
10M_organs.dat
10F_organs.dat
15M_organs.dat
15F_organs.dat

- 1510 • A list of the media, their elemental compositions, and densities (Annex B); the file names
 1511 are:

00M_media.dat
00F_media.dat
01M_media.dat

01F_media.dat
05M_media.dat
05F_media.dat
10M_media.dat
10F_media.dat
15M_media.dat
15F_media.dat

1514
1515
1516
1517

- A list of the skeletal tissue masses and surface areas in skeletal sites (Tables 3.3 to 3.8); the file names are:

00M_skeleton.dat
00F_skeleton.dat
01M_skeleton.dat
01F_skeleton.dat
05M_skeleton.dat
05F_skeleton.dat
10M_skeleton.dat
10F_skeleton.dat
15M_skeleton.dat
15F_skeleton.dat

1518
1519
1520

- A list of regional blood distributions (Table 4.3); the file names are:

00M_blood.dat
00F_blood.dat
01M_blood.dat
01F_blood.dat
05M_blood.dat
05F_blood.dat
10M_blood.dat
10F_blood.dat
15M_blood.dat
15F_blood.dat

1521
1522
1523
1524
1525
1526

(H 2) In the organ ID arrays, the organ IDs are listed slice by slice; within each slice, row by row; and within each row, column by column. That means, the column index changes fastest, then the row index, then the slice index. The numbers of columns, rows, and slices (i.e., the array dimensions) of the phantoms are given in Table 4.1 together with the voxel resolutions.