

## Research Article

---

# Forecasting Future Trends in Obesity across Europe: The Value of Improving Surveillance

Elisa Pineda<sup>a</sup> Luz Maria Sanchez-Romero<sup>a</sup> Martin Brown<sup>b</sup>  
Abbygail Jaccard<sup>b</sup> Jo Jewell<sup>c</sup> Gauden Galea<sup>c</sup> Laura Webber<sup>b</sup>  
João Breda<sup>c</sup>

<sup>a</sup>UCL Research Department of Epidemiology & Public Health, London, UK; <sup>b</sup>UK Health Forum, London, UK; <sup>c</sup>Nutrition, Division of Non-Communicable Diseases and Health Promotion through the Life-Course, WHO Regional Office for Europe, Copenhagen, Denmark

## Supplemental Material

# SUPPLEMENTARY APPENDIX

## *Annex 1. References for BMI by country*

Country	Citation	Data year(s)	Sample size		Age group	Measured / self-reported	National / regional data
			M	F			
<b>Albania</b>	Shapo et al., 2003	2001	535	585	24-65+	Measured	Regional
	Demographic and Health Survey	2009	2972	7330	15-49	Measured	National
<b>Andorra</b>	Enquesta nacional de salut d'Andorra, 1997	1997	71	83	60+	Self-reported	National
	Enquesta nacional de salut d'Andorra, 2002	2002	1300	1200	15-75+	Self-reported	National
	Enquesta nacional de salut d'Andorra, 2011	2011	473	447	15-75+	self-reported	National
<b>Armenia</b>	Demographic and Health Survey	2000	-	5962	15-49	Measured	National
	B. Roberts, personal communication	2001	745	1049	18-60+	Self-reported	National
	Demographic and Health Survey	2005	-	6016	15-49	Measured	National
	Watson K, et al. Micro- and meso-level influences on obesity in the former Soviet Union: a multi-level analysis. Eur J Public Health 2012;23:291–8.	2010	789	937	18-60+	Self-reported	National
<b>Austria</b>	Health Statistics Austria, 2002	1999	3368	3624	15-100	Self-reported	National

	Schwarz, Abdominal obesity and cardiometabolic risk factors in Austria, 2007	2006	528	526	30-74	Self-reported	National
	Klimont et al., Österreichische Gesundheitsbefragung, 2006/2007	2007	2914	3203	20-100	Self-reported	National
	Österreichische Gesundheitsbefragung, 2010–2012	2010–2012	231	384	18-80	Measured	National
<b>Azerbaijan</b>	WHO: Reproductive Health Survey	2001	-	1772	20-44	Measured	National
	Demographic and Health Survey	2006	2382	7793	15-49	Measured	National
	B. Roberts, personal communication	2010	789	821	18-60+	Self-reported	National
	Azerbaijan Statistical yearbook 2012	2011	2056	2194	15-65+	Unknown	National
	Azerbaijan Statistical yearbook 2014	2013	3305	3523	15-65+	Unknown	National
<b>Belarus</b>	B. Roberts, personal communication	2001	758	925	18-60+	Self-reported	National
	B. Roberts, personal communication	2010	764	991	18-60+	Self-reported	National
<b>Belgium</b>	Belgian Health Interview Survey, 1997	1997	3934	4137	15-100	Self-reported	National
	Belgian Health Interview Survey, 2001	2001	4582	4809	15-100	Self-reported	National
	Belgian Health Interview Survey, 2004	2004	4836	5483	15-100	Self-reported	National

		Belgian Health Interview Survey, 2008	2008	4093	4738	15-100	Self-reported	National
		Belgian Health Interview Survey, 2013	2013	4111	4515	18-75+	Self-reported	National
<b>Bosnia and Herzegovina</b>		WHO: Laatikainen T et al., 2002	2002	1118	1613	25-64	Measured	National
		Estimated from Global Burden of Disease mean data	2008					
<b>Bulgaria</b>		WHO; Survey of the health status of the population	2001	8008		25-74	Self-reported	National
		WHO; Petrova et al. 2006	2004	515	516	25-74	Self-reported	National
		Eurostat database: Health Interview Survey 2008 Bulgaria	2008	5664		25-84	Self-reported	National
		International Social Survey Programme: Health and Health Care - ISSP 2011	2011	422	581	20+	Measured	National
<b>Croatia</b>		WHO; Budak, 2003	97-99	1967	2982	0-100	Measured	National
		WHO; Croatian Adult Health Survey	2003	2878	6162	18+	Measured	National
		International Social Survey Programme: Health and Health Care - ISSP 2011	2011	575	635	20+	Measured	National
<b>Cyprus</b>		Statistical Service Cyprus, personal communication	2003	267866	284397	15-100	Self-reported	National

	Statistical Service Cyprus, personal communication	2008	277077	300761	15-100	Self-reported	National
<b>Czechia</b>	WHO; Sample Survey of the Health Status of the Czech Population HIS CR 1993	1993	734	833	20-74	Self-reported	National
	WHO; Sample Survey of the Health Status of the Czech Population 1996	1996	1031	1123	20-74	Self-reported	National
	WHO; Sample Survey of the Health Status of the Czech Population HIS 1999	1999	1603	1760	20-74	Self-reported	National
	WHO; Sample Survey of the Health Status of the Czech Population HIS 2002	2002	1142	1284	20-74	Self-reported	National
	Eurostat database: European Health Interview Survey 2008 Czech Republic	2008	940	1015	20-74	Self-reported	National
<b>Denmark</b>	SUSY 2000, National Institute of Public Health	2000	8126	8275	16-100	Self-reported	National
	Ekholm et al, Health and mortality survey Denmark, 2005	2006	7046	7441	16-100	Self-reported	National
	SUSY 2010, National Institute of Public Health	2010	79347	92873	16-100	Self-reported	National
<b>Estonia</b>	M. Tekeel, unpublished data	1998	561	743	16-64	Self-reported	National
	Kasmel et al. Health behaviour among Estonian adult population, spring 2000	2000	547	790	16-64	Self-reported	National
	Kasmel et al. Health behaviour among Estonian adult population, spring 2002	2002	542	779	16-64	Self-reported	National

	Tervise Arengu Instituut, Health behaviour among Estonian adult population	2004	1299	1743	16-64	Self-reported	National
	Tekkel et al. Health behavior among Estonian adult population, 2006	2006	1112	1706	16-64	Self-reported	National
	Tekkel et al. Health behavior among Estonian adult population, 2008	2008	1248	1702	16-64	Self-reported	National
	Tekkel and Veideman, Health behaviour among Estonian adult population 2010	2010	1227	1760	16-64	Self-reported	National
	Tekkel and Veideman, Health behaviour among Estonian adult population 2012		1235	2916	16-64	Self-reported	National
	Tekkel and Veideman, Health behaviour among Estonian adult population 2014	2014	1013	1525	16-64	Self-reported	National
<b>Finland</b>	WHO; Helakorpi et al, Health behaviour among Finnish adult population, 1998	1998	1689	1816	15-64	Self-reported	National
	WHO; Helakorpi et al., Health behaviour among Finnish adult population, 1999	1999	1523	1801	15-64	Self-reported	National
	WHO; Raitarki et al., Distribution and determinants of serum high-sensitive C-reactive protein	2001	1026	1193	20-39	Self-reported	National
	WHO; Helakorpi et al., Health behaviour among Finnish adult population, 2002	2002	1462	1757	15-64	Self-reported	National

WHO; Helakorpi et al., Health behaviour among Finnish adult population, 2003	2003	1516	1819	15-64	Self-reported	National
WHO; Helakorpi et al., Health behaviour among Finnish adult population, 2004	2004	1520	1805	15-64	Self-reported	National
WHO; Helakorpi et al., Health behaviour among Finnish adult population, 2005	2005	1500	1727	15-64	Self-reported	National
WHO; Helakorpi et al., Health behaviour among Finnish adult population, 2006	2006	1450	1761	15-64	Self-reported	National
WHO; Helakorpi et al., Health behaviour among Finnish adult population, 2007	2007	1397	1789	15-64	Self-reported	National
WHO; Helakorpi et al., Health behaviour among Finnish adult population, 2008	2008	1346	1776	15-64	Self-reported	National
Helakorpi et al., Health behaviour among Finnish adult population, 2009	2009	1240	1620	15-64	Self-reported	National
Helakorpi et al., Health behaviour among Finnish adult population, 2010	2010	1221	1539	15-64	Self-reported	National
Helakorpi et al., Health behaviour among Finnish adult population, 2011	2011	1181	1565	15-64	Self-reported	National
Helakorpi et al., Health behaviour among Finnish adult population, 2012	2012	1093	1456	15-64	Self-reported	National
Helakorpi et al., Health behaviour among Finnish adult population, 2013	2013	1080	1411	15-64	Self-reported	National

	Helakorpi et al., Health behaviour among Finnish adult population, 2014	2014	1109	1469	15-64	Self-reported	National
<b>France</b>	Maillard et al., Trends in the prevalence of obesity in the French adult population, 1999	1992	7250	7856	18-100	Self-reported	National
	Enquête épidémiologique nationale sur le surpoids et l'obésité, Roche 2009	1997	-	-	18-100	Self-reported	National
	Enquête épidémiologique nationale sur le surpoids et l'obésité, Roche 2009	2000	-	-	18-100	Self-reported	National
	Enquête épidémiologique nationale sur le surpoids et l'obésité, Roche 2009	2003	25770		18-100	Self-reported	National
	Enquête épidémiologique nationale sur le surpoids et l'obésité, Roche 2009	2006	-	-	18-100	Self-reported	National
	Eurostat database; Health Survey 2008 France	2008	3115		18-100	Self-reported	National
	Enquête épidémiologique nationale sur le surpoids et l'obésité, Roche 2009	2009	-	-	18-100	Self-reported	National
	Enquête épidémiologique nationale sur le surpoids et l'obésité, Roche 2012	2012	12214	13500	18-100	Self-reported	National
<b>Georgia</b>	B. Roberts, personal communication	2001	874	994	18-60+	Self-reported	National



<b>Germany</b>	Georgia STEPS survey 2010. K. Gvinianidze, personal communication	2010	1840	4453	18-64	Measured	National
	WHO; Hoffmester et al., National trends in risk factors for CVD in Germany, 1994	1991	2556	2715	25-69	Measured	Sub-national
	Microzensus 1999, Federal Statistics Office, personal communication	1999	24513	25765	18-100	Self-reported	National
	Microzensus 2003, Federal Statistics Office, personal communication	2003	24222	25235	18-100	Self-reported	National
	Microzensus 2005, Federal Statistics Office, personal communication	2005	25873	26654	18-100	Self-reported	National
	Nationale Verzehrs Studie II 2008, personal communication	2008	6117	7090	18-80	Self-reported	National
	Microzensus 2009, Federal Statistics Office, personal communication	2009	25112	25560	18-100	Self-reported	National
	German Health Interview and Examination Survey for Adults	2008–2011	3790	4198	18-79	Measured	National
<b>Greece</b>	Microzensus 2013, Health questions, Federal Statistics Office,	2013	23508	23589	18-75+	Self-reported	National
	Survey on income and living conditions, Hellenic Statistical Authority, personal communication	1998	4659710	5133801	15-100	Self-reported	National

	Survey on income and living conditions, Hellenic Statistical Authority, personal communication	1999	4428897	4912742	15-100	Self-reported	National
	Survey on income and living conditions, Hellenic Statistical Authority, personal communication	2000	4398975	4831754	15-100	Self-reported	National
	Survey on income and living conditions, Hellenic Statistical Authority, personal communication	2001	4360600	4867626	15-100	Self-reported	National
	WHO; Kapantais et al., 2004	2003	8234	9107	20-69	Self-reported	National
	Survey on income and living conditions, Hellenic Statistical Authority, personal communication	2009	4369422	4618038	15-100	Self-reported	National
	Hellas Health I Survey; F. Fillipidis, personal communication	2006	459	506	18+	Self-reported	National
	Hellas Health II Survey; F. Fillipidis, personal communication	2008	683	763	18+	Self-reported	National
	Hellas Health III Survey; F. Fillipidis, personal communication	2010	492	487	18+	Self-reported	National
<b>Hungary</b>	WHO: Boros et al., National health interview survey, 2003	2003	2214	2741	25-64	Self-reported	National
	Eurostat database: Health interview survey, 2008, Hungary	2009	5051		25-64	Self-reported	National

<b>Iceland</b>	E. Gisladdottir, personal communication	1990	557	577	15-80	Self-reported	National
	E. Gisladdottir, personal communication	2002	591	656	18-79	Self-reported	National
	E. Gisladdottir, personal communication	2007	2670	2995	18-79	Self-reported	National
	E. Gisladdottir, personal communication	2010	621	640	18-79	Self-reported	National
	Survey of Icelandic diet 2010/2011	2010/2011	625	646	18-80	Self-reported	National
<b>Ireland</b>	North/South Ireland food consumption survey	1998	2688	3074	18-64	Self-reported	National
	Survey of lifestyle, attitudes and nutrition in Ireland	2002	2164	3149	18-100	Self-reported	National
	Survey of lifestyle, attitudes and nutrition in Ireland	2007	942	1224	18-100	Measured	National
	Growing up in Ireland	2008	6761	7799	18-100	Measured	National
	Combined national adult nutrition survey and growing up in Ireland data	2009	8389	8415	18-100	Measured	National
	North/South Ireland food consumption survey	2010	361	375	18-100	Measured	National
	National adult nutrition survey 2011	2008/2010	740	760	18-90	Measured	National
<b>Italy</b>	Calza et al., Obesity and prevalence of chronic diseases, personal communication	2000	55303	59716	18-100	Self-reported	National

	WHO; Istituto Nazionale di Statistica. Stili di vita e condizioni di salute, 2004	2002	21851	23738	18-100	Self-reported	National
	WHO; Istituto Nazionale di Statistica. Stili di vita e condizioni di salute, 2004	2003	21233	23151	18-100	Self-reported	National
	WHO; Gallus et al., Overweight and obesity in Italian adults, 2004	2004	1407	1525	18-100	Self-reported	National
	WHO; Istituto Nazionale di Statistica. Health conditions and risk factors, 2007	2005	19384	21165	18-100	Self-reported	National
	Istituto Nazionale di Statistica. La vita quotidiana nel 2006, personal communication	2006	19378	21169	18-100	Self-reported	National
	Istat database, personal communication	2007	19187	20822	25-100	Self-reported	National
	Istat database, personal communication	2008	23522	25437	18-100	Self-reported	National
	Istat database, personal communication	2009	23689	25592	18-100	Self-reported	National
	Istat database, personal communication	2010	19151	21060	25-100	Self-reported	National
	Istat database Aspetti della vita quotidiana, 2013	2013	50000		18-75+	Self-reported	National
<b>Israel</b>	Keinar-Boken et al., 2005	2000	1371	1410	15-64	Self-reported	National
	A. Ifrah, personal communication	2002	3029	3287	18-64	Self-reported	National
	A. Ifrah, personal communication	2004	1455	1910	18-64	Self-reported	National
	A. Ifrah, personal communication	2008	1987	2199	21-64	Self-reported	National

	N. Goldberger, personal communication	2009	4880	5451	21-64	Self-reported	National
	N. Goldberger, personal communication	2010/2013					National
<b>Kazakhstan</b>	WHO: Demographic and Health Survey	1999	-	2238	15-49	Measured	National
	B. Roberts, personal communication	2001	802	986	18-60+	Self-reported	National
	B. Roberts, personal communication	2010	851	939	18-60+	Self-reported	National
	S. Tazhybayev, personal communication	2012	1299	2430	15-65+	Measured	National
<b>Kyrgyzstan</b>	WHO: Popkin BM and Martinchik AN, 1994	1993	2267	2647	18-100	Measured	National
	WHO: Demographic and Health Survey	1997	-	3518	15-49	Measured	National
	B. Roberts, personal communication	2001	845	988	18-60+	Self-reported	National
	Watson K et al. Micro- and meso-level influences on obesity in the former Soviet Union: a multi-level analysis. Eur J Public Health 2012;23:291–8.	2010	870	930	18-60+	Self-reported	National
	Kyrgyz Republic. Demographic and Health Survey 2012	2012	2413	8208	15-49	Measured	National
<b>Latvia</b>	Pudule et al. Health behaviour among Latvian adult population, 2002	2002	856	1091	15-64	Self-reported	National
	D. Krievkalne, unpublished data	2003	3189	3647	20-74	Self-reported	National

	Pudule et al., Health behaviour among Latvian adult population, 2004	2004	742	1014	15-74	Self-reported	National
	Pudule et al., Health behaviour among Latvian adult population, 2006	2006	665	873	15-74	Self-reported	National
	Eurostat database: European health interview survey, 2008, Latvia	2008	2867	3591	18-94	Self-reported	National
	Centre for Disease Prevention and Control	2012	1340	1631	15-64	Self-reported	National
<b>Lithuania</b>	WHO; Grabauskas et al., 1998	1998	811	1044	20-64	Self-reported	National
	WHO; Grabauskas et al., 2000	2000	989	1183	20-64	Self-reported	National
	Grabauskas et al. Lithuanian health behaviour monitoring, 2002	2002	1650	1027	20-64	Self-reported	National
	Grabauskas et al. Health behaviour among Lithuanian adult population, 2004	2004	757	1009	20-64	Self-reported	National
	S. Mačiukienė, unpublished data	2005	3801	5707	15-100	Self-reported	National
	Grabauskas et al., Health behaviour among Lithuanian adult population, 2006	2006	704	1001	20-64	Self-reported	National
	Grabauskas et al, Health behaviour among Lithuanian adult population, 2008	2008	715	994	20-64	Self-reported	National
	Grabauskas et al, Health behaviour among Lithuanian adult population, 2010	2010	578	1359	20-64	Self-reported	National

	Kriaucioniene V et al., The prevalence and trends of overweight and obesity among Lithuanian adults, 1994–2012, 2012	2012	716	1064	20-64	Self-reported	National
<b>Luxembourg</b>	Tchicaya and Lorentz, Vivre au Luxembourg, 2010	1995	-	-	16-64	Self-reported	National
	Tchicaya and Lorentz, Vivre au Luxembourg, 2010	2005	-	-	16-64	Self-reported	National
	Tchicaya and Lorentz, Vivre au Luxembourg, 2010	2008	-	-	16-64	Self-reported	National
<b>Malta</b>	WHO; Asciak et al., The first national health interview survey, 2003	2002	1844	2022	16-100	Self-reported	National
	National Health Survey 2007, personal communication	2007	151898	161082	18-65	Self-reported	National
	Eurostat database: European health interview survey, 2008, Malta	2008	-	-	18-100	Self-reported	National
	Euro Health Exam Survey, 2010	2010	110.5	110.5	18->60	Self-reported	National
	Grech et al.	2012	1777	1707	18->60	Self-reported	National
<b>Monaco</b>	No BMI data, France proxy adjusted for Monaco population size and structure	-	-	-	-	-	-
<b>Montenegro</b>	WHO: Health status and health needs in Serbia, 2002	2000	4458	4975	20-100	Measured	National
	Estimated from Global Burden of Disease mean dat	2008	-	-	-	-	-

Netherlands	Netherlands Statistiek	Central	Bureau voor de 2000	-	-	16-100	Self-reported	National
	Netherlands Statistiek	Central	Bureau voor de 2001	-	-	16-100	Self-reported	National
	Netherlands Statistiek	Central	Bureau voor de 2002	-	-	16-100	Self-reported	National
	Netherlands Statistiek	Central	Bureau voor de 2003	-	-	16-100	Self-reported	National
	Netherlands Statistiek	Central	Bureau voor de 2004	-	-	16-100	Self-reported	National
	Netherlands Statistiek	Central	Bureau voor de 2005	-	-	16-100	Self-reported	National
	Netherlands Statistiek	Central	Bureau voor de 2006	-	-	16-100	Self-reported	National
	Netherlands Statistiek	Central	Bureau voor de 2007	-	-	16-100	Self-reported	National
	Netherlands Statistiek	Central	Bureau voor de 2008	-	-	16-100	Self-reported	National
	Netherlands Statistiek	Central	Bureau voor de 2009	-	-	16-100	Self-reported	National
Netherlands Statistiek	Central	Bureau voor de 2010	-	-	16-100	Self-reported	National	



	Netherlands	Central	Bureau voor de	2011	-	-	16-100	Self-reported	National
	Statistiek								
	Netherlands	Central	Bureau voor de	2012	-	-	16 - ≥75	Self-reported	National
	Statistiek								
	Netherlands	Central	Bureau voor de	2013	-	-	17 - ≥75	Self-reported	National
	Statistiek								
	Netherlands	Central	Bureau voor de	2014	-	-	18 - ≥75	Self-reported	National
	Statistiek								
<b>Norway</b>	WHO: Johansson et al., 1998			1994	1461	1559	16-100	Self-reported	National
	Health interview survey			1998	3456	3669	16-100	Self-reported	National
	Health interview survey			2002	3410	3417	16-100	Self-reported	National
	WHO: Hougen HC, 2006			2005	3401	3365	16-100	Self-reported	National
	WHO: Wilhelmsen, 2009			2008	3172	3293	16-100	Self-reported	National
	Norwegian Institute of Public Health, 2012			2012	2174	2063	18-64	Self-reported	National
<b>Poland</b>	WHO; CINDI 2003			1992	792	904	25-64	Measured	Subnational
	Eurostat database: National health interview survey for Poland			1996	3137	9411	15-100	Self-reported	National
	Szponar et al. Household food consumption and anthropometric survey, 2003			2001	1949	-	19-100	Both	National

	Statistical Office	Poland,	personal	2004	19335	19446	15-70	Self-reported	National
	communication								
	Statistical Office	Poland,	personal	2009	11932	14673	15-70	Self-reported	National
	communication								
<b>Portugal</b>	Marques-Vidal et al.	Ten-year trends in	1996	38504		18-75	Self-reported	National	
	overweight and obesity	1995–2005; 2011							
	Marques-Vidal et al.	Ten-year trends in	1999	38688		18-75	Self-reported	National	
	overweight and obesity	1995–2005; 2011							
	WHO; Carmo et al.	Overweigh and obesity	2004	8116		18-64	Both	National	
	in Portugal, 2008								
	Marques-Vidal et al.	Ten-year trends in	2006	25348		18-75	Self-reported	National	
	overweight and obesity	1995–2005; 2011							
	Sardinha LB et al.,	Prevalence of	2009	3961	5484	18- >75	Self-reported	National	
	overweight, obesity, and abdominal								
	obesity in a representative sample of								
	Portuguese								
	adults, 2012								
<b>Republic of Moldova</b>	B. Roberts, personal communication		2001	816	973	18-60+	Self-reported	National	
	Demographic and Health Survey		2005	-	7062	15-49	Measured	National	
	B. Roberts, personal communication		2010	744	967	18-60+	Self-reported	National	
<b>Romania</b>	Eurostat database: National	health	2000	21200		15-100	Self-reported	National	
	interview survey, 2002, Romania								
	Eurostat database: European	health	2008	18172		18-100	Self-reported	National	
	interview survey, 2008, Romania								

	Corina Aurelia Zugravu, Research Gate, 2014 unpublished data	711	737	18->65	Self-reported	National
<b>Russian Federation</b>	Russia longitudinal monitoring survey, 1995 University of North Carolina, 2011	3364	4445	20-80+	Self-reported	National
	Russia longitudinal monitoring survey, 1996 University of North Carolina, 2011	3288	4382	20-80+	Self-reported	National
	Russia longitudinal monitoring survey, 1999 University of North Carolina, 2011	3399	4494	20-80+	Self-reported	National
	Russia longitudinal monitoring survey, 2000 University of North Carolina, 2011	3497	4719	20-80+	Self-reported	National
	Russia longitudinal monitoring survey, 2001 University of North Carolina, 2011	3859	5328	20-80+	Self-reported	National
	Russia longitudinal monitoring survey, 2002 University of North Carolina, 2011	4034	5484	20-80+	Self-reported	National
	Russia longitudinal monitoring survey, 2003 University of North Carolina, 2011	4089	5570	20-80+	Self-reported	National
	Russia longitudinal monitoring survey, 2004 University of North Carolina, 2011	4113	5593	20-80+	Self-reported	National
	Russia longitudinal monitoring survey, 2005 University of North Carolina, 2011	3997	5436	20-80+	Self-reported	National
	Russia longitudinal monitoring survey, 2006 University of North Carolina, 2011	4969	6609	20-80+	Self-reported	National

	Russia longitudinal monitoring survey, 2007 University of North Carolina, 2011	4950	6587	20-80+	Self-reported	National	
	Russia longitudinal monitoring survey, 2008 University of North Carolina, 2011	4693	6402	20-80+	Self-reported	National	
	Russia longitudinal monitoring survey, 2009 University of North Carolina, 2011	4708	6427	20-80+	Self-reported	National	
	Russia longitudinal monitoring survey, 2010 University of North Carolina, 2012	1140	1658	20-80+	Self-reported	National	
	Russia longitudinal monitoring survey, 2011 University of North Carolina, 2013	7554	1545	20-80+	Self-reported	National	
	Russia longitudinal monitoring survey, 2012 University of North Carolina, 2014	14936	20500	20-80+	Self-reported	National	
	Russia longitudinal monitoring survey, 2013 University of North Carolina, 2015	14225	19501	20-80+	Self-reported	National	
San Marino	No BMI data, Italy proxy adjusted for San Marino population size and structure	-	-	-	-	-	
Serbia	Grujic et al., 2002	2000	4458	4974	20-100	Measured	National
	T. Pavlica, unpublished data	2001-07	1865	2382	20-100	Measured	Regional
	Pavlica T, Božić-Krstić V, Rakić R.Body height and weight in adult population in Srem, Banat.	2011-2013	310	-	20 > 40	Measured	Regional

Faculty for Sciences, Department for  
Biology and Ecology

<b>Slovakia</b>	Eurostat database: National health interview survey, 2002 Slovakia	2002	1569	-	15-64	Self-reported	National
	Annual health report, Slovak Public Health Authority, personal communication	2006	1393	1443	15-65	Self-reported	National
	Eurostat database: European health interview survey, 2008, Slovakia	2009	1457	1423	15-65	Self-reported	National
	Annual health report, Slovak Public Health Authority, personal communication	2010	1437	1438	15-65	Self-reported	National
<b>Slovenia</b>	Eurostat database: National health interview survey, 2002, Slovenia	2001	1097		15-100	Self-reported	National
	Eurostat database: European health interview survey, 2008, Slovenia	2007	2118		18-100	Self-reported	National
<b>Spain</b>	National Statistics Institute online database, national health survey, 2003	2003	16296	17248	18-100	Self-reported	National
	National Statistics Institute online database, national health interview survey, 2006	2006	16911	16478	18-100	Self-reported	National
	National Statistics Institute online database, national health interview survey, 2009	2009	17558	17718	18-100	Self-reported	National

	National Statistics Institute online database, national health interview survey, 2009	2012	18295.5	19320.5	18 - >85	Self-reported	National
<b>Sweden</b>	WHO; Swedish survey of living conditions	1999	5587	5762	16-84	Self-reported	National
	WHO; Swedish survey of living conditions	2001	5515	5838	16-84	Self-reported	National
	Statistics Sweden, personal communication	2004	2742	2849	16-84	Self-reported	National
	Statistics Sweden, personal communication	2008	11118		16-84	Self-reported	National
	WHO; Enkätundersöknin 2009, Det nationella urvalet	2009	4570	5604	16-84	Self-reported	National
	Statistics Sweden, personal communication	2011	2633	2914	16-100	Self-reported	National
	Statistics Sweden, personal communication	2012-2013	9931	9765	16 - >85	Self-reported	National
<b>Switzerland</b>	WHO: Enquete Suisse sur la Sante 2003	1992	6749	8150	15-100	Self-reported	National
	WHO: Enquete Suisse sur la Sante 2003	1997	6716	7105	15-100	Self-reported	National
	WHO: Enquete Suisse sur la Sante 2003	2002	8843	10629	15-100	Self-reported	National
	WHO: Enquete Suisse sur la Sante 2009	2007	8339	10134	15-100	Self-reported	National
	Swiss Statistics	2012	3 350 658	3 487 610	15 - >75	Self-reported	National
<b>Tajikistan</b>	Estimated from Global Burden of Disease mean data	1995-2008	-	-	-	-	-

<b>The former Yugoslav Republic of Macedonia</b>	Estimated from Global Burden of Disease mean data	1995-2008	-	-	-	-	-
			-	-	-	-	-
<b>Turkey</b>	Erem et al., 2001	1998-1999	1324	1322	20-100	Measured	Subnational
	Turkish obesity and hypertension study, Hatemi et al., 2003	1999-2000	15144	4975	20-100	Measured	Subnational
	Yumuk et al., 2005	2001	5866	7000	20-100	Measured	Subnational
	Erem et al., 2004	2001-2002	2288	2728	20-69	Measured	Subnational
	Oguz et al., 2008	2004-2005	2110	2154	20-100	Measured	National
	Iseri et al., 2008	2007	2263	1942	20-85	Measured	National
<b>Turkmenistan</b>	Estimated from Global Burden of Disease mean data	1995-2008	-	-	-	-	-
<b>Ukraine</b>	WHO: CINDI programme, 2003	1995	788	892	25-64	Measured	Subnational
	B. Roberts, personal communication	2001	830	1229	18-60+	Self-reported	National
	WHO: Kravchenko et al., 2005	2002	-	856	15-49	Measured	National
	B. Roberts, personal communication	2010	794	1098	18-60+	Self-reported	National
<b>England</b>	Health Survey for England	2000	3260	3703	16-100	Measured	National
	Health Survey for England	2001	6267	7414	16-100	Measured	National
	Health Survey for England	2002	2969	3509	16-100	Measured	National
	Health Survey for England	2003	6519	6570	16-100	Measured	National

	Health Survey for England	2004	2772	2812	16-100	Measured	National
	Health Survey for England	2005	3144	3184	16-100	Measured	National
	Health Survey for England	2006	6014	6074	16-100	Measured	National
	Health Survey for England	2007	3008	2983	16-100	Measured	National
	Health Survey for England	2008	6385	6450	16-100	Measured	National
	Health Survey for England	2009	2055	2045	16-100	Measured	National
	Health Survey for England	2010	3563	3523	16-100	Measured	National
	Health Survey for England	2011	3478	3530	16-100	Measured	National
	Health Survey for England	2012	3475	3495	16-100	Measured	National
	Health Survey for England	2013	3688	3763	16-100	Measured	National
<b>Northern Ireland</b>	Northern Ireland health and social wellbeing survey 1997	1997	647	937	16+	Measured	National
	Northern Ireland health and social wellbeing survey 2005/06	2005/2006	1246	2437	16+	Measured	National
	Health survey Northern Ireland 2010/2011	2010/2011	1052	1302	16+	Measured	National
	Health survey Northern Ireland: first results	2013/2014	1521	1933	16+	Measured	National
<b>Scotland</b>	Scottish health survey 1995	1995	3303	4005	16-64	Measured	National
	Scottish health survey 1998	1998	3110	3783	16-74	Measured	National
	Scottish health survey 2003	2003	3016	3684	16+	Measured	National



<b>Wales</b>	Scottish health survey 2008	2008	2454	3019	16+	Measured	National
	Scottish health survey 2009	2009	2817	3449	16+	Measured	National
	Scottish health survey 2010	2010	2674	3327	16+	Measured	National
	Scottish health survey 2011	2011	2745	3389	16+	Measured	National
	Scottish health survey 2012	2012	1876	2221	16+	Measured	National
	Scottish health survey 2013	2013	1827	2280	16+	Measured	National
	Welsh health survey 2007	2007	6031	6765	16+	Self-reported	National
	Welsh health survey 2008	2008	6033	7097	16+	Self-reported	National
	Welsh health survey 2009	2009	6946	7753	16+	Self-reported	National
	Welsh health survey 2010	2010	7420	8579	16+	Self-reported	National
	Welsh health survey 2011	2011	7458	8600	16+	Self-reported	National
	Welsh health survey 2012	2012	7309	8378	16+	Self-reported	National
	Welsh health survey 2013	2013	6943	8064	16+	Self-reported	National
	Welsh health survey 2014	2014	6554	7616	16+	Self-reported	National
<b>Uzbekistan</b>	WHO: Demographic and Health Survey	1996	-	4038	15-49	Measured	National
	Demographic and Health Survey	2002	2058	4967	15-65	Measured	National
	Estimated from Global Burden of Disease mean data	2008	-	-	-	-	-

## **Annex 2. Methodology for BMI data categorization and processing**

*The method for projecting BMI was initially developed for the Foresight: Tackling obesity enquiry (24), and has since been implemented in over 70 countries (57, 58).*

### **BMI distributional data – age group standardisation**

BMI data exist for a variety of age groups and BMI groups (e.g. 20-24yrs, 20-29yrs, 20-34yrs). The aim is to produce a standardised set of age groups and BMI groups. The standardised age groups will be five-year age groups: 20-24, 25-29, 30-34, 35-39, etc. The BMI groups will be the standard WHO set: BMI<25 (ok), 25<BMI<30 (pre-ob), BMI≥30 (ob).

### **Projecting BMI data using previous prevalence**

#### **Computing BMI data**

The prevalence of body mass index (BMI) data found for this study was heterogeneous. We used different methodologies to obtain the BMI data needed to feed the model when it was not presented stratified by age group and sex, as it was needed to calibrate the model.

#### **1) Computing BMI data from non-age stratified BMI categories**

Armenia, France and Germany data for BMI categories was presented as an overall prevalence (i.e. non-age stratified). For these countries, the sample was divided proportionately for each age group based on the population size of each group obtained from United Nations population data and taking into account the totals by sex in the respective reports.

#### **2) Computing BMI by combining two data sources in a single data point.**

Data for Israel for 2013 were obtained by combining two sources, as numbers for 2013 were more accurate than those in the 2010 survey<sup>1</sup>. The numbers were obtained from the National Program for Quality Indicator in Community Healthcare, which collected information on obesity only from primary health care insurance funds. Pre-obesity and normal values were taken from the Central Bureau of Statistics survey 2010. The prevalence of normal weight was deduced by the difference between the two estimates, so the three BMI categories added up to 100%.

---

<sup>1</sup> Estimates were provided by Mrs Nehama Goldberger at the Health Information Department, Ministry of Health, Israel.

### 3) Computing BMI from a single data point.

Bosnia and Herzegovina, Montenegro and Uzbekistan had only one BMI data point (i.e. BMI categories prevalence for one year only); therefore, 2008 estimates were used on the basis of an analysis by Finucane and colleagues (1), with extrapolation from their estimated mean.

The distribution of BMI was assumed to have the form  $\{p, (1-p)/2, (1-p)/2\}$ , where  $p$  is the prevalence of normal weight;  $p$  is then determined from the known mean.

### 4) Computing BMI distribution from mean data

For the countries where no prevalence data was existent or available (Monaco, San Marino, Tajikistan, The former Yugoslav Republic of Macedonia and Turkmenistan) we extrapolated the mean data for each BMI category found from the Global Burden of Disease (GBD) study with the following assumptions:

#### Assumptions

##### Assumption 1

For each data-year,  $y$ ,  $\log(\text{BMI})$  has a Normal Distribution  $N(\mu(y), \sigma(y))$ .

##### Assumption 2

The value of  $\mu(y) = \ln(\text{mean-BMI}_{\text{GBD}}(y))$ .

Where  $\text{mean-BMI}_{\text{GBD}}$  is the mean BMI that has been extracted from the Global Burden of Disease study data.

##### Assumption 3:

The value of  $\sigma(y)$  is obtained from the GBD data for that year and the age-sex group by fitting a normal distribution to the  $\log(\text{BMI})$  data and taking the maximum likelihood (ML) estimate.

For each year, these assumptions allow computation of the probability ( $p$ ) of being in each of the BMI categories (healthy, pre-obese and obese):

$$p_{ok} \equiv P(BMI < 25) = \frac{1}{\sqrt{2\pi}\sigma(y)} \int_{-\infty}^{\ln(25)} dt \exp\left(-\frac{(t - \mu(y))^2}{2\sigma^2(y)}\right)$$

$$p_{ow} \equiv P(25 < BMI < 30) = \frac{1}{\sqrt{2\pi}\sigma(y)} \int_{\ln(25)}^{\ln(30)} dt \exp\left(-\frac{(t - \mu(y))^2}{2\sigma^2(y)}\right)$$

$$p_{ob} \equiv P(30 < BMI) = \frac{1}{\sqrt{2\pi}\sigma(y)} \int_{\ln(30)}^{\infty} dt \exp\left(-\frac{(t - \mu(y))^2}{2\sigma^2(y)}\right)$$

#### Assumption 4

The 95% confidence intervals for the three probabilities (p) above are derived from the 95% confidence interval for the mean of the GBD data. Thus, where  $cl^-$  is the lower 95% confidence limit and  $cl^+$  is the upper 95% confidence limit.

For example, to estimate the 95% CI of  $p_{ok} = P(BMI < 25)$ :

$$\frac{1}{\sqrt{2\pi}\sigma(y)} \int_{-\infty}^{\ln(25)} dt \exp\left(-\frac{(t - \mu(y) + cl^-(y))^2}{2\sigma^2(y)}\right) < P(BMI < 25) < \frac{1}{\sqrt{2\pi}\sigma(y)} \int_{-\infty}^{\ln(25)} dt \exp\left(-\frac{(t - \mu(y) - cl^-(y))^2}{2\sigma^2(y)}\right)$$

The difference between the upper and lower limits is taken as  $4\sigma$

Similar relations for pre-obesity and obesity give a data point for each year  $y$ :

$$\{(p_{ok}, \sigma_{ok}), (p_{ow}, \sigma_{pre-ob}), (p_{ob}, \sigma_{ob})\}$$

#### Predicting BMI

The most recent 10 years of the Global Burden of Disease (GBD) data (1) and associated  $\sigma$ -values from the Health Survey for England (2) are used as described to compile a text data entry file for the obesity\_distribution section of the modelling programme.

#### References

1. The Global Burden of Disease data. Seattle WA, USA. GBD Publications; 2016 (<http://www.healthdata.org/gbd/publications>, accessed 14 November 2016)
2. Health Survey for England. Leeds, West Yorkshire: NHS Digital.

#### 5) Computing BMI when only total sample size was presented

Data for Luxembourg since 2000 was disaggregated by age or sex, but only the total sample size (i.e. combining both sexes) was available (N=9500). Therefore, a total sample size of 9500 was applied to the two available data points. BMI by age group was used for both men and women, assuming equal distribution in each sample.

## 6) Computing BMI when no total sample size was presented

No sample sizes were available for the 14 annual data points used in the Netherlands so the sample size was estimated using an online tool for estimating the necessary size for a representative sample using total population size (Survey Systems tool <https://www.surveysystem.com/sscalc.htm>). Based on a 99% confidence level, the sample size calculated was 4159, using the formula below. This sample size was then divided proportionately for each age group based on population size for each age group taken from United Nations population data (2):

The sample size (SS) was calculated based on a 99% confidence level using the equation (59)

$$SS = \frac{Z^2 * (p) * (1 - p)}{C^2}$$

Where:

SS = sample size

Z = Z value (e.g. 2.58 for 99% confidence level)

p = percentage picking a choice, expressed as decimal (0.5 used for sample size needed)

C = confidence interval, expressed as decimal (e.g., 0.04 = ±4)

## 7) Computing BMI by combining countries estimates

The prevalence of BMI in the United Kingdom was calculated by summing the weighted prevalence for each of the component countries (England, Northern Ireland, Scotland

and Wales) for 2015, 2025 and 2035. The weights were estimated from total population projections (20–100 years old) for those years from the National Statistics database (4). The prevalence of pre-obesity and obesity in each country was then multiplied by their weight for every year to obtain the weighted prevalence. 95% confidence intervals for the United Kingdom were obtained from the following formula:

$$1.96 * \sqrt{(prev(1-prev)/sample\ size)}$$

where *prev* is the estimated projected prevalence of pre-obesity and obesity and *sample size* is that for the United Kingdom, which was obtained by summing the total samples sizes in each of the latest health surveys in the four countries: Health Survey of England 2013; Health Survey Northern Ireland 2013/2014; Scottish Health Survey 2013 and Welsh Health Survey 2014.

Population data (males and females in the total population) were taken from the 2011 United Nations population prospects. Information was obtained from the Office of National Statistics for England and Wales (4), the National Records for Scotland (5) and the Northern Ireland Statistics and Research Agency for Northern Ireland (6).

## References

1. Finucane MM, Stevens GA, Cowan MJ, Danaei G, Lin JK, Paciorek CJ, et al. National, regional, and global trends in body-mass index since 1980: systematic analysis of health examination surveys and epidemiological studies with 960 country-years and 9.1 million participants. *Lancet* 2011;377:557–67.
2. World population prospects, the 2015 revision. New York, NY: United Nations, Department of Economic and Social Affairs, Population Division; 2015 (<http://esa.un.org/unpd/wpp/index.htm>).
3. Systems CR. Sample Size Calculator Denmark. 2012 [Available from: <https://www.surveysystem.com/sscalc.htm>. Accessed 14 November 2016
4. National population projections, 2012-based projections. London: Office for National Statistics; 2013 (<http://www.ons.gov.uk/ons/publications/re-reference-tables.html?edition=tcn%3A77-318453>).

5. Secondary statistics & data. Edinburgh: National Records of Scotland; 2011 (<http://www.nrscotland.gov.uk/>, accessed 14 November 2016).
6. The population of Northern Ireland. Belfast: Northern Ireland Statistics and Research Agency; 2015 (<http://www.nisra.gov.uk/>, accessed 14 November 2016).

### ***Annex 3. Comparison of estimates from WHO and the UK Health Forum***

Estimates from WHO and the UK Health Forum were compared to determine whether there was any difference between the estimates that formed the basis for this projection exercise.

The age-standardized estimates in the most recent WHO global status report on non-communicable diseases (1), which were provided to the Global Burden of Metabolic Risk Factors of Chronic Diseases Collaborating Group, were derived from a review of published and unpublished literature of data for 2010–2014. The inclusion criteria included random samples of the general population, and adjustments were made for the standard definition of risk factor, the standard set of age groups reported, the standard reporting year and the representativeness of the population. Regression modelling was used to adjust the crude rates for each indicator, and age-standardized estimates were produced to facilitate comparisons among countries.

The projections of the UK Health Forum for 2015 were based on data from 2000 to the latest available year, extrapolated from past and current trends in cross-sectional data using multi-variate non-linear categorical regression modelling. Like the WHO estimates, those of the UK Health Forum relied on published and unpublished literature on BMI and the WHO BMI database (2), national statistical databases, public health institution and health surveillance reports and the PubMed and Science Direct databases; data were also collected by personal communication with researchers and public health officers. The inclusion criteria included BMI categorized according to WHO definitions, BMI data presented by age and/or sex and data available since 2000; self-reported data were also included.

Table A3.1 shows the projections for the prevalence of obesity generated by WHO for 2014 (1) and those of the UK Health Forum for 2015. The difference between the two varied by country. The largest differences were found for Germany, Italy, Lithuania and the Netherlands, for which the UK Health Forum estimates were lower than those of WHO, while the UK Health Forum reported higher estimates for Estonia, Greece, Ireland and the United Kingdom.



The greatest absolute differences among the 53 countries in the WHO European Region country for 2015 were found for Estonia and Italy. The estimate for Estonia was 9 percentage points higher in the UK Health Forum projections than the WHO estimates, and that for Italy was 9 percentage points lower.

**Table A3.1. Comparison of estimated prevalence of obesity ( $\geq 30\text{kg/m}^2$ ) by WHO in 2014 and the UK Health Forum in 2015\***

Country	WHO	Pineda et al, 2017
Albania	16%	7%
Andorra	28%	8%
Armenia	18%	15%
Austria	17%	21%
Azerbaijan	19%	4%
Belarus	21%	20%
Belgium	19%	15%
Bosnia and Herzegovina	17%	21%
Bulgaria	21%	13%
Cyprus	22%	20%
Czechia	25%	27%
Denmark	18%	17%
Estonia	21%	30%
Finland	19%	18%
France	22%	18%
Georgia	19%	53%
Germany	19%	16%
Greece	21%	26%
Hungary	23%	21%
Iceland	21%	27%
Ireland	23%	30%
Israel	24%	24%
Italy	20%	11%
Kazakhstan	21%	24%
Kyrgyzstan	13%	11%
Latvia	22%	20%
Lithuania	24%	22%
Luxembourg	21%	30%
Malta	25%	26%

Country	WHO	Pineda et al, 2017
Monaco	N/A	21%
Montenegro	19%	19%
Netherlands	18%	12%
Norway	21%	12%
Poland	23%	18%
Portugal	18%	21%
Republic of Moldova	14%	24%
Romania	20%	40%
Russian Federation	22%	26%
San Marino	N/A	12%
Serbia	18%	41%
Slovakia	23%	22%
Slovenia	23%	35%
Spain	22%	19%
Sweden	19%	14%
Switzerland	18%	11%
Tajikistan	12%	10%
The former Yugoslav Republic of Macedonia	18%	15%
Turkey	27%	33%
Turkmenistan	18%	11%
Ukraine	19%	18%
United Kingdom	26%	29%
Uzbekistan	14%	15%

\*Differences are percentage points.

## References

1. Global status report on noncommunicable diseases 2014. Geneva: WHO; 2014.
2. Global database on body mass index: an interactive surveillance tool for monitoring nutrition transition. Geneva: WHO; 2016 (<http://apps.who.int/bmi/index.jsp>, accessed 14 November 2016).

