Public Health Nutrition: 4(5A), 1099–1106 DOI: 10.1079/PHN2001191

Analyses of the anthropometric data from the North/South Ireland Food Consumption Survey

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Abstract

Objective: To obtain measured anthropometric data for weight, height and other parameters not previously measured in the Irish population such as waist and hip circumferences and body composition.

Design: A cross-sectional survey. Weight, height, waist circumference, hip circumference and body composition were measured according to standard procedures.

Setting: Northern Ireland and the Republic of Ireland, 1997–1999.

Subjects: Random representative sample of 1379 adults aged 18–64 years.

Results: With the exception of body fat, all anthropometric values were significantly higher for men than women ($P < 0.001$). All measurements were significantly higher in the 36–50-year-old age group compared with 18–35 year olds. Height was the exception, which decreased significantly with age ($P < 0.05$). Weight, height and body mass index (BMI) have increased in Ireland since last measured in 1988 and in 1990. Over the last decade, obesity has increased in men 2.5 fold from 8% to 20% and in women by 1.25 fold from 13% to 16%. Significantly more women have a normal BMI than men (50.4% vs. 33.3%; $P < 0.05$). Cut-off points for a high waist circumference and high waist-to-hip ratio identified 47% and 33% of the population, respectively, to be at an increased risk for cardiovascular disease. Social class did not have any significant effect on mean BMI. Location of residence influenced BMI but not in any consistent manner. Ex-smokers had a significantly higher BMI than non-smokers and smokers ($P < 0.05$).

Conclusions: A revision of current recommendations for combating obesity is warranted to improve the health of the Irish population. Further research is needed to identify the factors that have contributed to the dramatic increase in the prevalence of obesity in men over the last decade and have resulted in a higher prevalence of obesity in men than in women.

Keywords
Anthropometry
Ireland
BMI
Obesity
Waist circumference
Waist-to-hip ratio

Overweight and obesity are rapidly growing problems and are of major public health concern on a global basis. Obesity is a major risk factor for many metabolic disorders and non-communicable diseases such as diabetes, cardiovascular disease (CVD) and certain types of cancer[1]. Much of the increase in obesity has been attributed to high fat diets and sedentary lifestyles currently prevalent in Western countries[2,3]. National surveys in the UK and USA have shown a rapid rise in the prevalence of obesity in the last 10 years[4,5]. It has been reported that, in Australia, the population is gaining approximately 1 gram per day of body weight[6]. Recently, published data for Ireland suggests that there has been no change in the prevalence of obesity since 1990[7–9]. However, these data were self-reported which tends to be biased towards overreporting of height and underreporting of weight, resulting in very conservative estimates of obesity[7,10].

The present study set out to obtain up-to-date data on several anthropometric parameters for the populations of Northern Ireland and the Republic of Ireland and to include measurements of waist circumference, hip circumference and body composition, which have not previously been measured for these populations. In addition to body mass index (BMI), waist and hip

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measurements can be used to assess the need for weight management and predict the risks for cardiovascular disease in the population. Numerous publications have demonstrated that central adiposity measured by waist circumference and waist-to-hip ratio (WHR) is closely associated with risk factors that may ultimately lead to cardiovascular disease[11–15]. Cut-off points for waist circumference and waist-to-hip ratio have been defined to identify those people at a greater risk of having one or more cardiac risk factors such as high blood pressure, raised plasma lipids and increased insulin resistance[16–18]. These risk assessments are of utmost importance considering that cardiovascular disease is the single largest cause of death in Ireland, accounting for 43% of all deaths in 1997[19].

Methodology

Study sample

The North/South Ireland Food Consumption Survey (NSIFCS) was conducted between 1997 and 1999 and comprised of a random representative sample of 1379 adults aged 18–64 years of the populations in the Republic of Ireland and Northern Ireland. Data on food intake, health and lifestyle, physical activity, attitudes to food and health and anthropometry were collected. A detailed description of the methodology of this survey has been published elsewhere in this supplement[20].

Anthropometric measurements

All body measurements were performed in duplicate with the exception of height and body composition. Body weight was measured with the subject dressed in light clothing, after voiding and having removed keys and coins from pockets, using a Seca Alpha 770 digital scale (CMS Weighing Equipment Ltd, London, UK), calibrated in 100 g intervals. The surface on which the measurement was taken was recorded. Height was measured using a Leicester height measure to the nearest 0.1 cm (CMS Weighing Equipment Ltd, London, UK). The respondent removed shoes and stood upright ensuring that the heels, buttocks and scapulae were in contact with the backboard and the head positioned in the Frankfort Plane[21]. The respondent was asked to relax his/her shoulders, inhale and exhale before the height was measured. Waist and hip circumferences were measured in duplicate using a narrow metal Raybone Chesterman measuring tape calibrated in 1 mm intervals (CMS Weighing Equipment Ltd, London, UK). The waist was measured on the subject's left-hand side at the mid-point between the lowest point on the rib cage and the top of the iliac crest on the mid-auxiliary. When possible, the waist circumference was measured at the naked site. The hips were measured over the widest part of the buttocks at the level of the trochanters[22]. Body composition was measured using a Bodystat®1500 bioelectrical impedance analyser using the procedures recommended by the manufacturer (Bodystat Ltd, Douglas, Isle of Man, UK). After voiding, the subject lay supine for five minutes prior to the test. Exercise activities, alcohol and caffeine consumption and the time of last eating occasion were recorded for the previous 24 hours. Resting ECG disposable electrodes (Blue Sensor, Medicotest, Ltd, UK) were placed firmly on the right hand and the right foot, then body fat, lean body mass and body water were analysed for the subject.

BMI was calculated using weight and height (weight/height^2) and categorised according to World Health Organization (WHO) recommendations[1]. Two risk categories of waist circumference were used to identify subjects who were at an increased risk (men $\geq$94 cm, women $\geq$80 cm) or a high risk (men $\geq$102 cm, women $\geq$88 cm) of having at least one major cardiac risk factor[16,17]. A high risk of cardiovascular disease was also assessed using cut-off points for WHR, defined as $\geq$0.95 for men and as $\geq$0.80 for women as used by other authors[16,18]. The database from the Irish National Nutrition Survey (INNS) was re-analysed for 18–64 year olds, thus allowing for direct comparisons with the current study[23].

Statistical analysis

All statistical analyses were carried out using SPSS® Base 9.0 (SPSS Inc., Chicago, IL). The mean and standard deviation (SD) were calculated for weight, height, BMI, waist and hip circumferences, WHR and percentage body fat. As all measurements were normally distributed, independent *t*-tests and one-way analysis of variance (ANOVA) were used to test for significant differences in mean anthropometric measurements between gender, age groups and lifestyle factors. Significance was defined as $P < 0.05$. When ANOVA tables identified significant differences between age groups and lifestyle factors, *post hoc* tests were employed to identify which groups were significantly different. Equality of variance was assessed using Levene's test and that determined which *post hoc* test to use[24]. For groups of equal variance, significant differences between groups were tested using the Scheffe *post hoc* test (unless otherwise stated)[24]. When the Levene test was not satisfied and in addition the F-max score was greater than 3, the Tamhane *post hoc* test for unequal variance was used to identify significant differences between groups[24]. Cross tabulation identified the proportion of subjects in each of the BMI categories and the proportion of subjects in the defined risk categories for waist circumference and WHR, which were expressed as percentages. Significant differences between age groups and gender were tested using Chi-squared analysis[25].

Results

A complete set of anthropometric measurements was obtained for 73.2% of the sample. Response to each of the

Table 1 Mean anthropometric measurements and standard deviations (SDs) in Irish adults according to sex and age

		All ages 18–64 years			18–35 years			36–50 years			51–64 years		
		Mean	SD	*n*	Mean	SD	*n*	Mean	SD	*n*	Mean	SD	*n*
All	Weight (kg)	74.9	(15.0)	1369	72.5[a]	(14.9)	518	75.7[b]	(15.3)	520	77.4[b]	(14.3)	331
	Height (m)	1.68	(0.09)	1311	1.70[a]	(0.10)	505	1.67[b]	(0.09)	498	1.67[b]	(0.09)	308
	BMI (kg m^{-2})	26.3	(4.5)	1311	25.04[a]	(4.1)	505	26.8[b]	(4.4)	498	27.7[c]	(4.6)	308
	Waist circumference (cm)	87.0	(13.3)	1120	83.3[a]	(12.1)	442	87.8[b]	(13.5)	418	91.9[c]	(12.9)	260
	Hip circumference (cm)	102.8	(9.0)	1118	101.2[a]	(8.6)	441	103.5[b]	(8.8)	418	104.5[b]	(9.3)	259
	Waist-to-hip ratio	0.84	(0.09)	1118	0.82[a]	(0.08)	441	0.85[b]	(0.09)	418	0.88[c]	(0.09)	259
	Body fat (%)	27.8	(8.8)	1098	23.9[a]	(8.3)	441	29.3[b]	(7.9)	420	32.3[c]	(8.6)	237
Men	Weight (kg)	82.9*	(13.3)	655	81.0[a]	(13.3)	249	84.8[b]	(13.6)	235	83.2[ab]	(12.6)	171
	Height (m)	1.75*	(0.07)	613	1.77[a]	(0.07)	240	1.75[b]	(0.06)	217	1.73[b]	(0.07)	156
	BMI (kg m^{-2})	26.9*	(4.0)	613	25.8[a]	(3.6)	240	27.7[b]	(4.3)	217	27.6[b]	(3.6)	156
	Waist circumference (cm)	94.3*	(11.3)	492	90.3[a]	(10.5)	198	96.6[b]	(11.7)	167	97.6[b]	(10.1)	127
	Hip circumference (cm)	104.1*	(7.6)	491	103.0[a]	(7.8)	197	105.4[b]	(7.7)	167	104.1[ab]	(6.9)	127
	Waist-to-hip ratio	0.91*	(0.07)	491	0.88[a]	(0.06)	197	0.92[b]	(0.07)	167	0.94[c]	(0.06)	127
	Body fat (%)	21.2*	(5.8)	495	17.7[a]	(5.0)	203	22.7[b]	(5.3)	177	24.0[c]	(3.8)	115
Women	Weight (kg)	67.5	(12.5)	714	64.6[a]	(11.6)	269	68.1[b]	(12.3)	285	71.1[b]	(13.3)	160
	Height (m)	1.62	(0.06)	698	1.63[a]	(0.06)	265	1.62[b]	(0.06)	281	1.60[c]	(0.06)	152
	BMI (kg m^{-2})	25.8	(4.8)	698	24.4[a]	(4.3)	265	26.1[b]	(4.4)	281	27.8[c]	(5.5)	152
	Waist circumference (cm)	81.2	(11.7)	628	77.5[a]	(10.2)	244	81.9[b]	(11.2)	251	86.6[c]	(13.0)	133
	Hip circumference (cm)	101.8	(9.8)	627	99.6[a]	(8.9)	244	102.3[b]	(9.3)	251	104.9[c]	(11.2)	132
	Waist-to-hip ratio	0.80	(0.07)	627	0.78[a]	(0.06)	244	0.80[b]	(0.06)	251	0.82[c]	(0.07)	132
	Body fat (%)	33.2	(7.1)	603	29.2[a]	(6.7)	238	34.1[b]	(5.7)	243	39.1[c]	(5.6)	122

* Denotes significant differences found between men and women for each of the mean anthropometric measurements at $P < 0.001$.
[abc] Different superscripts within a row denote significant differences between age groups at $P < 0.05$.

individual measurements varied. Of the 1379 subjects who participated in the survey, weight was obtained for 99%, height 95%, WHR 81% and body fat 79.6%.

Table 1 summarises the mean anthropometric results, for all subjects combined, all males, all females and by three age groups. For almost all of the anthropometric variables, for both males and females, significantly higher ($P < 0.05$) values were observed in the 36–50-year-old age group compared with those aged 18–35 years. Height was the exception in that there was a small but statistically significant ($P < 0.05$) decline across these age groups.

In men, the majority of the anthropometric measurements did not significantly increase further in the 51–64-year-old age group, compared with the younger age groups, with the exception of waist-to-hip ratio and percentage body fat. These measurements were significantly greater ($P < 0.05$) in the 51–64-year-old men. A slight decrease in both weight and hip measurements occurred after 50 years of age in men and these were the only measurements that were not significantly higher in the 51–64-year-old age group compared with 18–35 year olds. In women, all of the anthropometric measurements, with the exception of weight and height, were significantly greater ($P < 0.05$) in the 51–64-year-old age group. Height showed a small but significant ($P < 0.05$) decline. For all age groups combined (18–64 years), the anthropometric values were significantly higher ($P < 0.001$) for men than for women with the exception of body fat, where, as expected, females had a significantly higher value.

The percentage of the population in the different BMI categories is given in Table 2. For the total population, less than 1% were underweight, 42.4% were in the normal range, 39% were pre-obese (overweight) and 17.8% were obese. The majority of the obese subjects were in class I obesity (BMI = 30.0–34.9 kg m^{-2}) and less than 1% were morbidly obese (BMI ≥ 40 kg m^{-2})[1]. For all age groups, a higher proportion of women were in the normal BMI category ($P < 0.05$). The proportion of the total population in the normal category decreased significantly ($P < 0.001$) with increasing age. Conversely, in the pre-obese and obese categories, the proportions increased significantly up to the 36–50-year-old age group ($P < 0.05$). Only in females in the obese category did this increase significantly in the 51–64-year-old age group. Due to the small number of subjects in obese classes I, II and III, no comparisons were made.

Waist circumference and WHR are presented in Table 3, where the data are expressed as a percentage of the population at varying levels of risk for cardiovascular disease as previously defined[16]. In both males and females, the percentage of subjects in the risk categories increased with increasing age group for both waist circumference and WHR. For the total population combined and for each gender, there was a significantly greater proportion of both the 36–50 and 51–64 year olds in the increased and high risk categories of waist circumference, compared with 18–35 year olds ($P < 0.05$). Contrary to trends in BMI, significantly more men were in the normal risk category of WHR than women ($P < 0.001$), while significantly more women were in the increased risk category ($P < 0.001$). The proportion of both men and women in the increased risk category of WHR increased significantly between the 18–35 year age

Table 2 Percentage of Irish adults in each BMI category according to sex and age group

	Age group	*n*	Underweight (BMI ≤ 18.49 kg m^{-2})	Normal (BMI = 18.5–24.9 kg m^{-2})	Pre-obese (BMI = 25.0–29.9 kg m^{-2})	Obese† (BMI ≥ 30 kg m^{-2})	Class I (BMI = 30.0–34.9 kg m^{-2})	Class II (BMI = 35.0–39.9 kg m^{-2})	Class III (BMI ≥ 40.0 kg m^{-2})
All	18–64 years	1311	0.8	42.4	39.0	17.8	13.3	3.7	0.9
	18–35 years	505	1.6	54.9[a]	32.5[a]	11.1[a]	8.5	2.4	0.2
	36–50 years	498	0.2	38.2[b]	42.6[b]	19.1[b]	13.9	3.6	1.6
	51–64 years	308	0.3	28.9[b]	43.8[b]	27.0[c]	20.1	5.8	1.0
Men	18–64 years	613	0.3	33.3*	46.3*	20.1	16.3	3.3	0.5
	18–35 years	240	0.8	44.6[a]	41.3[a]	13.3[a]	12.1	1.3	
	36–50 years	217		26.7[b]	48.9[b]	24.4[b]	18.0	5.1	1.4
	51–64 years	156		25.0[b]	50.6[b]	24.4[b]	20.5	3.8	
Women	18–64 years	698	1.1	50.4	32.5	15.9	10.6	4.0	1.3
	18–35 years	265	2.3	64.2[a]	24.5[a]	9.1[a]	5.3	3.4	0.4
	36–50 years	281	0.4	47.0[b]	37.7[b]	15.0[b]	10.7	2.5	1.8
	51–64 years	152	0.7	32.9[b]	36.8[b]	29.6[c]	19.7	7.9	2.0

† Obese group consists of all three classes of obesity (i.e. BMI ≥ 30 kg m^{-2}).
* Denotes significant difference between men and women of same age groups and BMI category at $P < 0.05$.
[abc]Different superscripts within a column denote significant differences between age groups at $P < 0.05$.

group and the 36–50 year age group ($P < 0.05$). This increased significantly in the 51–64 year age group for men only.

Table 4 examines the association of BMI with socio-economic, demographic and lifestyle factors. Social class was not significantly associated with mean BMI in men or women, in any of the age groups. Location of residence appeared to influence BMI but not in any consistent manner across age and sex groups. In women, there appears to be a difference in mean BMI between those residing in the countryside and the city. For all subjects combined, ex-smokers (daily) had a significantly higher mean BMI ($P < 0.05$) compared with non-smokers, who in turn had a significantly higher mean BMI ($P < 0.05$) than smokers.

Discussion

This is the first survey of its kind to have combined anthropometry data from Northern Ireland and the Republic of Ireland using the same protocols and methodology. The mean anthropometric data from both the North and the South did not differ significantly from each other with respect to weight, height and BMI. The entire N/S database can therefore be directly compared with previous surveys (Irish National Nutrition Survey (INNS) and Diet, Lifestyle and Health in Northern Ireland (DLHNI)) to track any changes that have occurred with time[23,26] (Table 5).

Table 5 compares the current data with results from previous studies and indicates that mean weight, height and BMI have increased in both men and women over the last 10–12 years. Weight appears to have increased more in men than in women, with an approximate weight gain of 0.55 kg and 0.33 kg per year, respectively, since the INNS and the DLHNI survey. This can be translated into the entire population gaining approximately 1 gram per day of body weight, a figure precisely similar to the population of Australia[6]. Mean height in males and females has also increased by approximately 1–2 cm.

Obesity has increased to 17.8%, which represents a 1.7 fold increase compared with INNS data and a 1.5 fold increase compared with the DLHNI survey[23,26] (Table 5). Obesity in men has increased 2.5 fold from 7.8% to 20% over the last decade[23]. The proportion of obese females has increased 1.25 fold, from 12.9% to 15.9%, in 10 years[23]. In the total sample, the proportion of subjects in the normal category of BMI has decreased from 49.5% to 42.4%, while the pre-obese (0.9% increase) and underweight (0.9% decrease) categories have remained relatively unchanged during this time[23].

A striking finding from these data is that the prevalence of obesity in men has increased more rapidly than in women, with the prevalence of obesity in men (20%) now exceeding that in women (15.9%). On a world-wide scale, the prevalence of obesity is generally higher among

Table 3 Percentage of Irish adults with increasing risk for CVD as defined by waist circumference[16,17] and WHR[18] according to sex and age

		Waist circumference†				WHR‡		
	Age group	*n*	Normal risk	Increased risk	High risk	*n*	Normal risk	Increased risk
All	18–64 years	1120	52.4	24.1	23.5	1118	66.6	33.4
	18–35 years	442	69.0[a]	17.0[a]	14.0[a]	441	79.8[a]	20.2[a]
	36–50 years	418	45.0[b]	29.7[b]	25.4[b]	418	62.4[b]	37.6[b]
	51–64 years	260	36.2[b]	27.3[b]	36.5[c]	259	51.0[c]	49.0[c]
Men	18–64 years	492	52.4	24.4	23.2	491	77.8*	22.2*
	18–35 years	198	69.2[a]	17.7[a]	13.1[a]	197	89.3[a]	10.7[a]
	36–50 years	167	43.1[b]	29.9[b]	26.9[b]	167	77.8[b]	22.2[b]
	51–64 years	127	38.6[b]	27.6[b]	33.9[b]	127	59.8[c]	40.2[c]
Women	18–64 years	628	52.4	23.9	23.7	627	57.9*	42.1*
	18–35 years	244	68.9[a]	16.4[a]	14.8[b]	244	72.1[a]	27.9[a]
	36–50 years	251	46.2[b]	29.5[b]	24.3[b]	251	52.2[b]	47.8[b]
	51–64 years	133	33.8[c]	27.1[b]	39.1[c]	132	42.4[b]	57.6[b]

† Waist circumference – normal risk: <94 cm for men and <80 cm for women; increased risk: 94–101.9 cm for men and 80–87.9 cm for women; high risk: ≥102 cm for men and ≥88 cm for women.
‡ WHR – normal risk: <0.95 for men and <0.80 for women; increased risk: ≥0.95 for men and ≥0.80 for women.
* Denotes significant difference between men and women, $P < 0.05$.
[abc] Different superscripts within a column denote significant differences between age groups at $P < 0.05$.

Table 4 Mean BMI values and standard deviations (SDs) in Irish adults (18–64 years) by sex and lifestyle factors

	All			Men			Women		
	Mean	SD	*n*	Mean	SD	*n*	Mean	SD	*n*
Social class									
Professional	25.9	(3.8)	126	26.9	(3.8)	57	25.1	(3.6)	69
Managerial/Technical	26.6	(4.3)	427	27.3	(3.8)	198	25.9	(4.6)	229
Non-manual	26.1	(4.8)	237	27.1	(4.7)	82	25.6	(4.9)	155
Skilled manual	26.6	(4.4)	246	27.0	(3.9)	141	26.0	(5.0)	105
Semi-skilled	26.1	(4.6)	159	26.2	(4.3)	74	26.1	(4.9)	85
Unskilled	26.8	(5.0)	44	26.9	(3.2)	28	26.7	(7.2)	16
Student	24.1	(3.0)	32	24.7	(2.8)	19	23.3	(3.3)	13
Location of residence									
Open country & village	27.0[a]	(4.6)	458	27.2	(4.2)	221	26.8[a]	(4.9)	237
Small town (1500–9999)	26.0[ab]	(4.1)	146	27.2	(3.8)	69	24.9[b]	(4.0)	77
Large town (>10 000)	26.7[a]	(4.4)	220	27.1	(3.4)	104	26.4[ab]	(5.0)	116
City	25.7[b]	(4.4)	487	26.4	(4.1)	219	25.0[b]	(4.6)	268
Smoking habits									
Smoker	25.2[a]	(3.9)	342	25.9[a]	(3.7)	167	24.5[a]	(4.0)	175
Smoker (occasionally)	25.5[ac]	(3.7)	80	26.6[ab]	(3.4)	33	24.6[c]	(3.6)	47
Ex-smoker (daily)	27.9[b]	(4.3)	182	28.1[b]	(3.6)	108	27.6[b]	(5.1)	74
Ex-smoker (occasionally)	26.4[abc]	(3.9)	133	27.6[ab]	(3.4)	53	25.7[abc]	(4.0)	80
Never smoked	26.7[c]	(4.9)	561	27.0[ab]	(4.3)	244	26.4[bc]	(5.3)	317

[abc] Different superscripts within a column denote significant differences in lifestyle factors at $P < 0.05$.

Table 5 Comparison of mean anthropometric measurements in NSIFCS with previous large-scale nutrition surveys in the Republic of Ireland and the UK

			Men						Women					
			Weight		Height		BMI		Weight		Height		BMI	
	Age range	Obesity (%)	kg	*n*	m	*n*	kg m^{-2}	*n*	kg	*n*	m	*n*	kg m^{-2}	*n*
NSIFCS	18–64 years	17.8	82.9	655	1.75	613	26.9	613	67.5	714	1.62	698	25.8	698
INNS, 1990[23]	18–64 years	10.7	78.1	256	1.74	256	25.7	256	64.8	334	1.61	334	24.9	334
DNSBA, 1990[36]	16–64 years	10*	75.9	1194	1.75	1160	24.9	1158	64.3	1189	1.62	1163	24.6	1161
DLHNI, 1988[26]	16–64 years	12	75.3	265	1.74	265	24.9	265	62.9	341	1.60	341	24.6	341

* Calculated as BMI > 30 kg m^{-2}.

women than in men, with the exception of Finland and The Netherlands[1]. In The Netherlands a similar prevalence of obesity was reported for men and women (8% for both) in 1995, whereas in Finland a slightly higher prevalence of obesity has been found in men for the last 15 years (14% men; 11% women)[1]. These trends are of considerable importance with respect to public health. Given that the prevalence of obesity in men has increased so rapidly and that obesity is an independent risk factor for heart disease[4], which results in 23% of deaths in Irish men aged up to 65 years[19], this dramatic increase in male obesity amplifies the public health concerns regarding obesity.

The changes in the BMI profile of the population may have occurred in the following manner. The decrease in the proportion of the population in the normal BMI category of 7.1 percentage points and the similar increase of 7.1 percentage points in the obese category suggest that some of the formerly normal weight individuals have become overweight (pre-obese), while some of the overweight individuals have become obese. This has resulted in the perception that the pre-obese (overweight) BMI category has remained unchanged whereas actually it has been in a constant state of flux but with no net change. Similar findings have been observed in the USA, where the percentage of people in the pre-obese category has remained relatively unchanged with only a 1.5% difference between 1962 and 1994, while obesity has increased 1.5 fold from 1980 to 1994[5].

The Department of Health and Children in the Republic of Ireland proposed recommendations for a reduction in both overweight (pre-obese) and obesity by 10% by 2005 and the Department of Health in the UK recommended a reduction in obesity of 25% and 33% for men and women, respectively[27,28]. Given that the prevalence of obesity has increased by 67%, a review of these recommendations is therefore warranted. From these data, it appears that a turnover of those occupying the pre-obese group will not be noticed if the relative size of the pre-obese group does not change. For future recommendations, attention must be focused on the normal BMI category. Before proposing modifications to these recommendations, additional analysis is required to identify and characterise the individuals in the pre-obese group and assess their risk of becoming the next obese generation. Only then can recommendations be specifically targeted at reversing the current trend towards obesity and perhaps allow an increase in the relative size of the normal BMI category.

A decrease of energy intake, a higher proportion of dietary energy derived from fat and a more sedentary lifestyle have been shown to contribute to the increasing prevalence of obesity[2,3]. McGowan *et al.* revealed that overall energy intakes in Ireland did not change remarkably in the last 10–12 years while Harrington *et al.* showed that the percentage food energy from fat was lowest in the 51–64-year-old age group[29,30]. Physical activity data analysed by Livingstone *et al.* have shown that there is a reduced total work activity and recreational activity in the obese group along with more TV viewing than in the non-obese[31]. However, all of these findings must be interpreted with some caution, since the obese are more inclined to underreport energy intakes and fat intakes[32–34]. Furthermore, these physical activity data are cross-sectional and do not necessarily reflect the long-term overall patterns of activity. Further investigation is required to identify the groups that need targeting and the approaches that should be followed so that the population might adopt future recommendations.

Recently published data from the WHO MONICA project compared waist and hip circumferences and waist-to-hip ratios in 19 different populations[35]. The mean waist circumference, hip circumference and WHR for men and women in this survey were comparable to those measured for many of the countries examined in the project. The limitation of these comparisons is that although the data from the MONICA project were published recently, the measurements were taken nearly 10 years ago.

In Table 3, the categories of increased risk and high risk of waist circumference represent a 1–2.5 times and 2–4.5 times increased risk, respectively, of having one or more major cardiac risk factors[16,17]. Approximately half of the sample is at a greater risk (increased risk and high risk combined 47.6%) of having at least one major risk factor for cardiovascular disease. The high-risk category (23.5%) corresponds with the level at which symptoms of breathlessness and arthritis begins to develop due to overweight[16]. The group of subjects in the increased risk category must be discouraged from further weight gain and an increase in waist circumference towards the high-risk category. WHR cut-off points indicated that approximately one-third of the population was at an increased risk for cardiovascular disease risk factors. Waist circumference seems to identify a greater proportion of the population that is above normal risk compared with WHR. However, the identification of risk using waist circumference is population-specific and depends on many issues including levels of overweight and obesity[1]. Therefore both waist circumference and WHR require further analyses in conjunction with BMI and body fat to determine the sensitivity of these cut-off points in identifying the subjects at an increased risk of cardiovascular disease in this population.

It is important to note that social class was not significantly associated with mean BMI. The Dietary and Nutritional Survey of British Adults (DNSBA) reported that those in higher social classes had a significantly lower BMI[36]. It is of interest that there seems to be a country-side/city influence on BMI in females. This group needs further investigation in order to identify what underlying factors are producing this effect. Smoking and BMI demonstrated a strong association, with smokers having

a significantly lower BMI. It has been suggested that smokers have an altered metabolism or increased metabolic rate resulting in lower body weight and BMI[37]. However, the hazardous effects of smoking are far more detrimental to health than the ill effects of weight gain due to cessation of smoking, as smokers have higher mortality rates at all levels of BMI[38].

The data presented here are first-level analyses and require further investigation to formulate recommendations. However, certain findings are very alarming, such as the dramatic increase in the prevalence of obesity, especially in men, and the proportion of the population with high waist circumference and WHR. The significant increase with age for BMI, waist circumference, WHR and percentage body fat suggests the need to (1) target the young in the population with preventative strategies, to prevent them becoming the next obese generation, and (2) target the older population to attain a healthy body weight and encourage an active lifestyle. In addition to preventative strategies, special attention must be given to identify the factors that have resulted in such a dramatic increase in the prevalence of obesity in men over the last decade.

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