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A Prospective Analysis of the Relationship between Chronic Diseases and Adiposity in older adults: Findings from the Lifeways Cross-Generation Cohort Study of a Thousand Families in Ireland 2001-2014

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Abstract

This study assesses the relationship between body mass index (BMI) and adult chronic diseases (diabetes mellitus type 2 [DM2], cardiovascular diseases [CVD] and cancers), in grandparents in the Lifeways Cross-Generation Cohort Study. BMI was either measured or reported, at baseline or 10-year follow-up, in 1,244 grandparents. Cumulative morbidity data were recorded at baseline, 3 and 10-year follow-up through questionnaires, General Practice note search or both. 42.4% of grandparents were overweight and 32.1% obese. In the multivariate analysis BMI showed a strong linear association with both DM2 (p_{trend}<0.001) and CVD (p_{trend}<0.001). There were no significant associations with cancers, but case numbers were small. Results were similar for waist circumference. This prospective study presents novel Irish data and confirms other recent Irish cross-sectional reports on adiposity and adult chronic disease, highlighting the need for effective health promotion interventions in older adults.

Introduction

While the prevalence of obesity has begun to stabilise in some countries in the adult population, Ireland has demonstrated one of the highest increases in prevalence in the last decade.[1] According to the 2011 National Adult Nutrition Survey,[2] the most dramatic increase in obesity among Irish

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adults was observed in 51-64 year old men, rising from 11% to 42% over the past two decades. SLÁN

2007,[3] reported men aged 45+ were more likely to be classified as overweight than women, 49% vs.

39% respectively. The latest report on the Irish Longitudinal Study on Ageing, TILDA, highlights that

35% of older Irish adults are classified as obese according to their body mass index (BMI) and a

further 44% are overweight.[4] The report also highlights that just over half of older Irish adults are at

a substantially increased risk of metabolic and cardiovascular diseases (CVD) based on their waist

circumference(WC).[4] The aim of this study was to examine the relationships between

anthropometric parameters (BMI, WC), and selected chronic diseases (DM2, CVD and cancers),

employing data from the prospective Lifeways study. Previous reports have been cross-sectional

only; this is novel in that it appears to be the first longitudinal analysis of the association between

measures of adiposity and chronic disease outcomes in Ireland.

Methods

The Lifeways Cross-Generation Cohort Study, which was established during 2001–2003 through two

Irish maternity hospitals, is a unique Irish longitudinal database. A randomly selected sample of

1,124 expectant Irish-born mothers was recruited while they were attending their first ante-natal

visit. The index mothers in the Lifeways study were found to be representative of the general Irish

female population.[5]

At recruitment all mothers were asked if, in addition to their infant and partner, they would attempt

to recruit to the project at least one available living grandparent. Where more than one grandparent

was available, selection was rotated at random from maternal grandmother, paternal grandmother,

maternal grandfather and paternal grandfather. The grandparents' consent was obtained by sending

an information letter and a consent form. Consent was also sought for a clinical examination during

a home visit. Longitudinal follow-up is on-going in 2015. Detailed design of this study has been previously described.[6,7]

The data used in this study was provided by 1,244 grandparents (from 632 families), aged 37-90 years who participated in the study. BMI was either measured or reported at baseline or measured only at 10-year follow-up, with priority given to measured variables. Cumulative morbidity data were recorded at enrolment by questionnaire and a physical examination.[7, 8] 3 and 10-year follow-up data was collected through questionnaires, General Practice note search or both. A physical examination was also undertaken at 10 years. The cumulative data used in this study gives information on grandparent's health status and adiposity measures as of beginning of 2014. A diagnosis of CVD included CVD risk factors, i.e. hypertension, angina, high cholesterol, myocardial infarction and stroke. BMI was computed as weight in kilograms over height in meters squared (kg/m^2). WC was measured in cm. Based on BMI cut-off points recommended by the World Health Organization (WHO),[9] the grandparents were classified into three categories: low/normal-weight (BMI <24.9 kg/m^2), overweight (BMI 25–29.9 kg/m^2) and obese (BMI ≥30 kg/m^2). For WC three health-risk categories were used:[9] low risk (women <79.9 cm, men <93.9 cm), increased risk (women 80-87.9 cm, men 94-101.9 cm) and high risk (women ≥88.0 cm, men ≥102 cm). Only grandparents with complete data on age, sex and BMI are included in the current analysis. Numbers of grandparents differ for different analyses due to missing values for covariates.

Univariate analyses were conducted using chi-square tests (or Fisher's exact test if assumptions were not met) to assess whether there was a difference between the prevalence of the various chronic diseases, and BMI (n=1,244) and WC (n=1,055). Odds Ratios (ORs) and 95% confidence intervals (95% CIs) were estimated by logistic regression analysis for BMI (n=1,176) and WC (n=988) and adjusted for age and sex in model 1 and age, sex and education level in model 2. All analyses were conducted for both sexes combined and separately. Finally, we examined whether the BMI source (self-reported vs. measured) influenced our results. All analyses were performed using the STATA

statistical software package (version 13). All p-values were based on two-sided tests and considered statistically significant if <0.05.

Results

Table 1 presents a summary of the descriptive characteristics of the 1,244 included grandparents. BMI far exceed normal-weight categories[9] with 42.4% overweight and 32.1% obese. Furthermore, measurements of central adiposity found that 52.0% of the grandparents had a WC in the 'high risk' and 28.3% in the 'increased risk' category.

Table 2 shows the results of univariate analyses between BMI and chronic diseases. Significant differences between BMI and DM2 and CVD were observed (p<0.001) for men and women combined, with more grandparents being overweight and/or obese when diagnosed with DM2 or CVD compared to grandparents not diagnosed with these diseases. Similar patterns were observed for analyses stratified by sex (Table 2). BMI was not significantly associated with cancers (p>0.05). When this analysis was restricted to those 1158 respondents with BMI at baseline the findings were very similar , with DM2 and CVD outcomes being strongly significantly associated with BMI patterns (each <0.001) but not cancers.

Next, the differences between WC and chronic diseases in grandparents were examined in univariate analyses (Table 3), showing similar patterns as for BMI.

Table 4 shows the logistic regression models assessing the associations of BMI and WC with selected diseases. DM2 risk increased significantly and linearly with increasing BMI when adjusted for age and sex (model 1; p_{trend}<0.001). Compared to normal-weight grandparents, overweight grandparents had a 3.5 times higher risk of being diagnosed with DM2; this was even ten-fold for obese grandparents. Adjusting additionally for education level (model 2) showed similar results. Similar patterns were observed for WC. Also for CVD, risks increased significantly and linearly with increasing BMI or WC category, although the increase was less sharp compared to DM2. For cancers, no significant

association was observed with either BMI or WC. When this analysis was restricted to those with BMI at baseline findings were similar (data not shown).

We also examined the relationship with BMI source (self-reported vs. measured; data not shown), which was found to be significant in women only (p<0.001). A higher percentage of women with measured BMI were categorised as overweight or obese vs. women with self-reported BMI (74.5% vs. 51.4%, respectively). When restricting the analyses to measured BMI only (n=1,001; Table 4), results were similar for DM2 and CVD to the overall results. For cancers, a significantly increased risk was observed for obese grandparents but not for overweight grandparents compared to normal-weight grandparents. Similar results were observed when restricting the analyses to those with BMI at baseline.

Discussion

The current study shows high rates of overweight and obesity but furthermore, we found a clear linear relationship between adiposity and diagnosed DM2 and CVD during the study follow-up period. These data are prospective, showing clearly in an Irish context that overweight and obesity translate into adult morbidity, especially for cardiovascular diseases. When the analyses were restricted to those with BMI only at baseline the findings were very similar. It is likely that this is because body mass index patterns, which are known to track strongly in adulthood were established in these respondents,[10] though we do not address this repeat measures question directly in this analysis. Lack of a statistically significant association between adiposity and cancers in men and women in the overall analyses most probably reflects the relatively small number of study grandparents with this condition (n=142). Another possible explanation may be the inclusion of 'all cancers', many of which are not associated with adiposity. Whilst grandparents in this study were more likely at baseline to report co-morbidities than the SLÁN population[8], their prevalence rates of overweight/obesity are similar to those reported in other surveys.[3,4]

In older adults, obesity can be diagnosed easily and inexpensively using anthropometric measures. Clinical guidelines have suggested in the past that both BMI and WC should be considered when assessing a patient's risk of adiposity-related disease[9,11] and findings from this study support this. However, the relation between measures of general and central adiposity and clinical endpoints remains understudied in older adults and more research is needed in this area.[12,13]

Analysis of the source of BMI data revealed interesting results. Significant differences were found in proportions of BMI measurements in women in the overweight/obese category in the 'measured' vs. 'self-reported' groups. These differences indicate a possible underestimation of the true prevalence of obesity in women when using self-reported data. A study analysing data from three SLÁN surveys in Ireland reports similar findings.[14] Based on self-reported values among persons 70 years and older it is estimated that there is a 14-27% underestimation of people who are overweight.[15] In addition, the results of the multivariate analyses on cancers in the current study became stronger when restricting to measured BMI only. The implications for practice are clear; BMI determined from self-reported variables is less reliable in to monitoring obesity trends in populations.[14]

The major strengths of this study are its prospective design, its relatively large size and availability of exposure information and endpoints which have been carefully reviewed and repeatedly updated. Follow-up rates in this study have been very high. Inclusion of the grandparents in the Lifeways Study is of considerable importance in developing our understanding of how risk for chronic disease is transmitted across generations and through the life course of individuals. An ageing population and the increasing prevalence of adiposity will create a significant burden of morbidity with major resource implications, unless measures are taken to stem the obesity epidemic.[16]

Epidemiologic studies examining the relationship between body weight and risk of morbidity and mortality in older adults have many methodological challenges.[17,18] The most important of these is the problem of reverse causation, in which weight loss resulting from illness can distort the relationship between leanness and health.[18] Of the chronic diseases examined in the current study, only pre-existing cancer might have resulted in weight loss in our population. However, as >80% of

cancer cases were diagnosed after BMI or WC was measured, this will most probably not have affected our results.

Other variables included that were not found to be significant confounders in this analysis were child's birth weight, accommodation and smoking. However, we cannot exclude the possibility of residual confounding by unmeasured variables.The cohort in this study was composed predominately of indigenous white Irish individuals and the application of these findings to other racial and ethnic groups is unclear.

To conclude, this prospective study presents novel Irish data which confirm other recent Irish cross-sectional reports on adiposity and adult chronic disease. Furthermore, there are health concerns for older adults in Ireland because of a high prevalence of overweight and obesity and our growing and ageing population. Tackling the high rates of overweight and obesity must be a priority for public health intervention.

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Table 1 . Descriptive statistics of grandparents in the Lifeways Cross-Generation Cohort Study stratified by sex (total n = 1244)

	Male & Female				Male				Female			
	n[a]	%	Mean	SD[b]	n[a]	%	Mean	SD[b]	n[a]	%	Mean	SD[b]
Age (years)	1244		61.7	9.9	487		63.2	9.9	757		60.7	9.6
BMI (kg/m^2)[c]	1244		28.4	5.5	487		28.3	4.6	757		28.4	6.0
BMI categories[c,d]												
Low/normal	317	25.5			99	20.3			218	28.8		
Overweight	528	42.4			235	48.3			293	38.7		
Obese	399	32.1			153	31.4			246	32.5		
BMI source[c]												
Baseline self-reported	175	14.1			68	14.0			107	14.1		
Baseline measured	858	69.0			326	66.9			532	70.3		
10-year follow-up measured	211	17.0			93	19.1			118	15.6		
WC (cm)[e]	1055		95.3	13.1	417		100.9	11.0	641		91.7	13.1
WC categories[e,f]												
Low	207	19.6			103	24.9			104	16.2		
Increased	299	28.3			129	31.2			170	26.5		
High	549	52.0			182	44.0			367	57.3		
DM2[g]												
No	1127	90.6			436	89.5			691	91.3		
Yes	117	9.4			51	10.5			66	8.7		
CVD[h]												
No	460	37.0			188	38.6			272	35.9		
Yes	784	63.0			299	61.4			485	64.1		
Cancers												
No	1140	91.6			445	91.4			695	91.8		
Yes	104	8.4			42	8.6			62	8.2		
Smoking												
No	262	22.6			66	14.8			196	27.5		
Yes	897	77.4			380	85.2			517	72.5		
Education Level												
No school/primary school	489	41.6			198	43.5			291	40.4		
Some secondary school	340	28.9			118	25.9			222	30.8		
Complete secondary education	183	15.6			60	13.2			123	17.1		
Some third level	79	6.9			35	7.7			44	6.1		
Complete third level	85	7.2			44	9.7			41	5.7		

[a]Number of grandparents do not add up to the total number because of missing values for covariates

[b]SD, Standard deviation

[c]BMI, Body Mass Index

[d]BMI categories defined as follows: Low/normal (<25 kg/m2); Overweight (≥25-<30 kg/m2); Obese (≥30 kg/m2)

[e]WC, Waist Circumference

[f]WC categories defined as follows: Low risk (Women <80 cm, Men <94 cm); Increased risk (Women ≥80 - <88 cm, Men ≥94 – <102 cm); High risk (Women ≥88 cm, men ≥102 cm)

[g]DM2, diabetes mellitus type 2

[h]Cardiovascular disease including risk factors i.e. hypertension, angina, high cholesterol, myocardial infarction and stroke

Table 2 . Univariate analyses for body mass index (BMI; kg/m^2)[a] categories (measured and reported combined) and chronic diseases among grandparents of the Lifeways Cross-Generation Cohort Study

	Male & female (n=1,244)					Male (n=487)					Female (n=757)				
	BMI categories					BMI categories					BMI categories				
	Low/normal	Overweight	Obese	χ^2	p-value	Low/normal	Overweight	Obese	χ^2	p-value	Low/normal	Overweight	Obese	χ^2	p-value
DM2[b]				44.47	<0.001				10.30	0.006				37.48	<0.001
No	27.4	43.1	29.5			22.0	48.4	29.6			30.8	39.8	29.4		
Yes	6.8	35.9	57.3			5.9	47.1	47.1			7.6	27.3	65.2		
CVD[c]				27.63	<0.001				6.35	0.042				22.91	<0.001
No	33.5	40.7	25.9			25.5	47.9	26.6			39.0	35.7	25.4		
Yes	20.8	43.5	35.7			17.1	48.5	34.5			23.1	40.4	36.5		
Cancers				0.72	0.698				2.36	0.307				1.19	0.551
No	25.8	42.2	32.0			20.7	47.2	32.1			29.1	39.0	31.9		
Yes	22.1	45.2	32.7			16.7	59.5	23.8			25.8	35.5	38.7		

[a]BMI categories defined as follows: Low/normal (<25 kg/m^2); Overweight (≥25-<30 kg/m^2); Obese (≥30 kg/m^2)

[b]DM2, diabetes mellitus type 2

[c]Cardiovascular disease including risk factors, i.e. hypertension, angina, high cholesterol, myocardial infarction and stroke

Table 3 . Univariate analyses for waist circumference (WC; cm)[a] categories and chronic diseases among grandparents of the Lifeways Cross-Generation Cohort Study

	Male & female (n=1,055)					Male n=414)					Female (n=641)				
	WC categories					WC categories					WC categories				
	Low risk	Increased risk	High risk	χ^2	p-value	Low risk	Increased risk	High risk	χ^2	p-value	Low risk	Increased risk	High risk	χ^2	p-value
DM2[b]				37.97	<0.001				15.94	<0.001				-[c]	<0.001
No	21.5	29.4	49.1			27.4	31.7	40.9			17.8	27.9	54.3		
Yes	2.0	18.6	79.4			4.4	26.7	68.9			0.0	12.3	87.7		
CVD[d]				37.83	<0.001				6.27	0.043				36.10	<0.001
No	28.7	29.5	41.8			30.6	32.5	36.9			27.4	27.4	45.1		
Yes	14.4	27.7	57.9			21.4	30.4	48.3			10.1	26.0	63.9		
Cancers				1.22	0.543				0.08	0.959				1.83	0.401
No	19.9	28.6	51.5			25.0	31.0	44.0			16.5	27.0	56.5		
Yes	16.9	25.3	57.8			23.3	33.3	43.3			13.2	20.8	66.0		

[a]WC categories defined as follows: Low risk (women <80 cm, men <94 cm); Increased risk (women ≥80-<88 cm, men ≥94–<102 cm); High risk (women ≥88 cm, men ≥102 cm)

[b]DM2, diabetes mellitus type 2

[c]Fisher's exact test applied as cell count is zero in one cell

[d]Cardiovascular disease including risk factors, i.e. hypertension, angina, high cholesterol, myocardial infarction and stroke

Table 4. Associations of BMI [a] and WC [b] with selected chronic diseases among grandparents in the Lifeways cross generation cohort study (Odds ratios adjusted for age, sex and education)

	Odds ratio of BMI (kg/m2)[a] and WC (cm)[b] categories with chronic disease								
	DM T2[c]			CVD[d]			Cancers		
Variable	OR[e]	95% CI[f]	*p value* for trend	OR[e]	95% CI[f]	*p value* for trend	OR[e]	95% CI[f]	*p value* for trend
BMI Groups[g]			<0.001			<0.001			0.332
Low/normal	1	Ref		1	Ref		1	Ref	
Overweight	3.65	1.60 - 8.33		1.94	1.42 - 2.63		1.32	0.77 - 2.26	
Obese	9.62	4.28 - 21.59		2.46	1.76 - 3.43		1.34	0.76 - 2.38	
BMI Groups (measured only)[g]			<0.001			<0.001			0.062
Low/normal	1			1			1		
Overweight	4.76	1.65-13.71		2.04	1.45-2.87		1.88	0.96-3.70	
Obese	13.71	4.84-38.84		2.66	1.85-3.84		2.03	1.01-4.08	
WC Groups[h]			<0.001			<0.001			0.338
Low/normal	1	Ref		1	Ref		1	Ref	
Increased	5.62	1.27 - 25.00		1.81	1.23 - 2.67		1.11	0.54 - 2.31	
High	16.62	3.99 - 69.13		2.73	1.91 - 3.91		1.34	0.69 - 2.58	

[a] Body mass index
[b] Waist Circumference
[c] Diabetes Mellitus Type2
[e] Cardiovascular disease including risk factors i.e. hypertension, angina, high cholesterol, myocardial infarction and stroke
[e] Odds Ratio
[f] Confidence Interval
[g] BMI groups defined as follows: Low/normal: BMI < 24.9kg/m^2 Overweight: BMI 25 -29.9kg/m^2 Obese: BMI ≥ 30kg/ m^2
[h] WC Groups defined as follows: Low risk (Women < 79.9 cm, Men < 93.3 cm) Increased risk (Women 80 - 87.9 cm, Men 94 – 101.9 cm) High risk (Women ≥88.0 cm, men ≥ 102 cm)