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Research report

Association between meal intake behaviour and abdominal obesity in Spanish adults ☆

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ABSTRACT

The study aims to evaluate the association between abdominal obesity with meal intake behaviour such as having a forenoon meal, having an afternoon meal and snacking. This cross-sectional study includes n = 1314 participants aged 20–79 who were interviewed during the Cardiac health "Semanas del Corazon" events in four Spanish cities (Madrid, Las Palmas, Seville and Valencia) in 2008. Waist circumference, weight and height were assessed to determine abdominal obesity (waist circumference: ≥88 cm in women and ≥102 cm in men) and BMI, respectively. The intake of forenoon and afternoon meal and snacking between the participants' regular meals were assessed with a questionnaire that also included individual risk factors. The information obtained about diet was required to calculate an Unhealthy Habit Score and a score reflecting the Achievement of Dietary Guidelines. Adjusted logistic regressions were used to examine the association between abdominal obesity and the mentioned meal intake behaviour controlling for sex, age, individual risk factors, BMI and diet. Having an afternoon meal (OR 0.60; 95% CI (0.41–0.88)) was negatively associated with abdominal obesity after adjusting for all confounders, whereas the positive association of snacking (OR 1.39; 95% CI (1.05–1.85)) was not independent of BMI (OR 1.25; 95% CI (0.84–1.87)). Taking a forenoon meal did not show any associations (OR 0.92; 95% CI (0.63–1.34)) with abdominal obesity. The results obtained could be helpful in the promotion of healthy habits in nutritional education programmes and also in health programmes preventing abdominal obesity.

Introduction

Central or abdominal obesity (AO) is independently associated with increased risk of cardiovascular diseases, type 2 diabetes and metabolic disorders, which demonstrates that it is not only the accumulation of fat per se but its distribution in the body that determines a direct health risk (Després, 2012). AO has multifactorial causes, including genetic and behavioural factors (WHO, 2008). Although the former is not modifiable within a short period of time, the latter changed dramatically during the last decades and therefore might be one of the principal sources of the obesity epidemic observed in most of the world's populations (Popkin, 2001). Diet and physical activity are behavioural factors that mainly contribute to the energy imbalance. Thus, their investigation is of importance to provide information for prevention and treatment of AO (WHO, 2000). Numerous studies have been conducted to identify which nutrients or food groups are related to weight gain (Mesas, Muñoz-Pareja, López-García, & Rodríguez-Artalejo, 2012). But the results found are inconsistent as their effect might be minimized when investigated separately (Gargallo Fernández et al., 2012). Consequently, research started to pay attention to meal intake behaviours (MIB) as they may unify different food groups and nutrients, and therefore have been shown to be important in the obesity research (Mesas et al., 2012).

MIB – such as the eating frequency, the daily number and kind of meals taken, as well as snacking – is shown to be associated with Body Mass Index (BMI) and central obesity (Berg et al., 2009; Deshmukh-Taskar, Nicklas, Radcliffe, O'Neil, & Liu, 2012; Holmbäck, Ericson, Gullberg, & Wirfält, 2010; Ma et al., 2003; Marín-Guerrero, Gutiérrez-Fisac, Guallar-Castillón, Banegas, & Rodríguez-Artalejo, 2008; Mesas et al., 2012; van der Heijden, Hu, Rimm, & van Dam, 2007) and also to regulate food intake (Holmbäck et al., 2010; Howarth, Huang, Roberts, Lin, & McCrory, 2007; Kerver, Yang, Obayashi, Bianchi, & Song, 2006). Eating frequency is one of the most investigated MIB, but the relations found with obesity are controversial, perhaps due to the fact that eating occasions – meals and snacks – are generally not investigated separately and/or the kind of meal is not specified. For example, Gigante, Barros, Post, and Olinto (1997) and Ma et al. (2003) showed that a lower frequency of obesity was associated with eating more than three times per day

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compared to three times or less, whereas Howarth et al. (2007) observed that eating frequency of more than six times compared to three or less was associated with a higher BMI. In contrast, Berg et al. (2009) did not find any associations between obesity and eating frequency. However, when eating frequency was evaluated separately defining meals and snacks, only the latter was positively associated with BMI, whereas eating snack food also has been homogeneously found to be associated with weight gain (Howarth et al., 2007; Mesas et al., 2012). Thus, differentiating between meals and snacks might be of importance to obtain explicit results as the quantity and, moreover, the quality of the food ingested may vary when perceiving an eating occasion as meal or as snack (Wadhera & Capaldi, 2012; Wansink, Payne, & Shimizu, 2010). On the other hand most previous studies do not consider AO as an independent health indicator. A systematic review (Mesas et al., 2012) examining the association between selected eating behaviours and excess body weight reported only two studies that investigated eating frequency and snacking considering waist circumference or AO in adults as outcome variable (Halkjaer, Tjønneland, Overvad, & Sørensen, 2009; Holmbäck et al., 2010).

In the Spanish population there are commonly two traditional meals between the three main meals (breakfast, lunch and dinner), named 'media mañana' (forenoon meal) and 'merienda' (afternoon meal). Both are underexplored due to the lack of differentiation within the eating occasions (meal vs. snack). As both eating occasions are perceived as meals their consequences over the food intake (Keller, Rodríguez López, Carmenate Moreno, & Acevedo Cantero, 2014) and their quality and quantity (Wadhera & Capaldi, 2012; Wansink et al., 2010) may differ from snacking, and therefore they might be associated with different health indicators. Hence, the present study aims to evaluate the association between AO and MIB such as forenoon meal, afternoon meal and snacking between the regularly taken meals in Spanish adults.

Materials and methods

Study population

This cross-sectional study examined data from 1314 adults, 831 women and 483 men, aged between 20 and 79 (mean age 57.8 ± 14.9 years), who were interviewed in 2008 in four Spanish cities (Madrid, Las Palmas, Seville and Valencia) during the "Semanas del Corazon" (Weeks of the heart) events organized by the "Fundación Española del Corazón" and the "Sociedad Española de Cardiología". As the purpose of these events was to identify cardiovascular risk factors and to transmit recommendations for healthier lifestyles, we did not carry out a random selection but accepted all voluntaries. Hence, the sample includes a greater number of women as well as older persons, which might represent those population groups with a higher health consciousness and/or a higher risk perception for cardiovascular disease. The study included all subjects within the abovementioned age range who took part in the measurements of height, weight and waist circumference, and who completed a questionnaire that provided information about age, sex and lifestyle factors. Participants were excluded if they could not visit the event without help, i.e., when they were supported by other persons or used a wheelchair. A written informed consent was obtained before the anthropometric measurements and the questionnaire was carried out by trained persons. Standardized anthropometric instruments were used, following the recommendation of the International Biological Program (Weiner & Lourie, 1981). This study was conducted according to the guidelines laid down in the Declaration of Helsinki (WMA, 2013) and all procedures involving human participants were approved by the ethical commission of the 'Fundación Española del Corazón'.

Anthropometric variables

AO was estimated from waist circumference – which was measured midway between the lowest rib and the iliac crest – considering the cut-off points of 88 cm in women and 102 cm in men (Alberti et al., 2009; NCEP, 2001). The calculation of BMI was based on measurements of weight and height, employing the equation of weight (kg) divided by the square of height. When necessary the participants were classified as normal weight (18.5–24.9 kg/m^2), overweight (25–29.9 kg/m^2) and obese (≥30 kg/m^2) according to WHO (2000).

Meal intake behaviour

The MIB considered were: (i) the intake of the forenoon meal and (ii) afternoon meal and (iii) snacking between the participants' regularly taken meals. They were assessed by questioning whether the participants had regular breakfast, forenoon meal, lunch, afternoon meal and dinner, asking separately for those five meals (1 = yes/2 = no). To rate for snacking behaviour, participants were asked if they eat between their regular meals (1 = yes/2 = no). We also created a variable to assess the intake of all the three main meals (1 = yes, breakfast, lunch and dinner were regularly eaten/2 = no).

Dietary variables

We created a score reflecting the Achievement of the Dietary Guideline (ADGS). Therefore, we assessed the usual daily consumed portion of five food groups: (i) meat, fish and eggs, (ii) milk and dairy products, (iii) fruit, (iv) vegetables, and (v) bread, pasta, rice and cereal. We recoded them based on the daily recommended consumption, following the Spanish dietary guidelines presented by Salvador Castell, Mataix Verdú, and Serra-Majem (2006). One point was obtained for each food group when the daily recommended consumption was achieved: (a) meat, fish and eggs (less than three rations), (b) milk and dairy products (more than one ration), (c) fruit (more than one ration), (d) vegetables (more than one ration), and (e) bread, pasta, rice and cereals (more than three rations). To prevent very small frequencies within the ADGS range (0–5) the score was categorized as: 1 = very low (0–1), 2 = low (2), 3 = middle (3) and 4 = high (4–5).

We also created an Unhealthy Habit Score (UHS) based on the regular consumption of: (i) fatty food, (ii) ready-made meals and (iii) salty food, (iv) the use of salt on already cooked meals, and (v) the intake of sugary drinks with the meals (1 = yes/2 = no). Points were given when participants confirmed each specific habit. The score ranged from 0 to 5, but was recoded as 1 = very low (0), 2 = low (1), 3 = middle (2) and 4 = high (3–5) for the analysis.

Individual risk factors

Finally, we assessed individual risk factors such as smoking, alcohol consumption and physical activity during leisure time. The alcohol consumption and smoking were determined when asking whether the habits were conducted (1 = yes/2 = no). Physical activity performed during leisure time was based on the self-reported level of the carried out activity (coded 1 = sedentary lifestyle, 2 = light exercise, and 3 = moderate and/or intensive exercise).

Statistical analysis

Study population characteristics according to sex and AO were analysed through Student's t-test/Mann–Whitney U-test and χ^2 test, for continuous and categorical variables, respectively. First, we evaluated the associations between the MIB (in this case they were used as a dependent variable) and the confounders (sex, age, individual

risk factors, the intake of the three main meals, BMI, ADGS and UHS) by using logistic regression, controlling for the mutual effect within the MIB by introducing in the analysis those MIB not used as dependent variables. Thereafter, logistic regression models assessed the association between the risk of experiencing AO (dependent variable) and the MIB (main independent variable). Model 1 adjusted for the covariates age, sex, smoking, drinking alcohol, physical activity performed in leisure time and the intake of all the three main meals. Models 2, 3 and 4 added BMI, the Achievement of the Dietary Guideline Score and the Unhealthy Habit Score, respectively. Finally, Model 5 introduced all the confounders in the regression. The software package SPSS 17 was used to conduct the statistical analysis considering p-value < 0.05 as statistically significant.

Results

The characteristics of the sample according to sex and the prevalence of AO are shown in Table 1. Women compared to men showed a higher percentage of AO, but a smaller frequency of overweight, whereas both sexes showed the same likelihood to be obese. No age differences were found between men and women, but men were more likely to smoke, to drink alcohol and to perform moderate or intensive physical activity during their spare time, whereas women were more likely to perform light exercise or be sedentary. Women also achieved higher frequencies in the middle and high categories of the ADGS and the very low category of the UHS. Of the total sample, about 30% realized a forenoon meal compared to nearly half who regularly had an afternoon meal, whereas only a quarter of the participants usually snacked between their regular meals. Men were less likely to have a forenoon as well as an afternoon meal, whereas no significant differences were observed according to AO. Participants with AO compared to those without AO did not show differences regarding the ADGS or the UHS. But the former were less likely to perform moderate or intensive physical activity, to drink alcohol or to smoke.

Table 2 shows the association between the investigated MIB – forenoon meal, afternoon meal and snacking – with the confounders. None of the investigated MIB showed association with sex, age, the individual risk factors and BMI, or with the confounder: realization of all of the three main meals. The higher categories of the ADGS compared to the very low category increased the probability of having an afternoon meal, whereas the probability of having a forenoon meal increased only with the high category of this score. In contrast to the other two MIB, snacking did not show associations with this confounder but its probability increased with the higher categories of the UHS. One can also observe that having an afternoon meal was associated with having a forenoon meal and vice versa, whereas associations with snacking were not found.

The associations between AO and the three MIB are described in Table 3. Having a forenoon meal did not show associations with AO, whereas the intake of the afternoon meal was associated negatively with AO, even after adjusting for all confounders. In

Table 1
Study population characteristics according to sex and abdominal obesity.

	Sex n (%)/Mean ± SD			Abdominal obesity n (%)/Mean ± SD			Total
	Men (n = 483)	Women (n = 831)	p-Value	Yes (n = 651)	No (n = 663)	p-Value	
WC (cm)	97.7 ± 10.3	90.1 ± 12.0	<0.001	100.8 ± 8.9	85.2 ± 9.3	<0.001	92.9 ± 12.0
Normal WC	314 (65.0)	349 (42.0)	<0.001				663 (50.5)
Abdominal obesity	169 (35.0)	482 (58.0)					651 (49.5)
BMI (kg/m^2)[a]	28.2 ± 3.6	28.1 ± 5.0	0.067	30.9 ± 4.1	25.4 ± 2.9	<0.001	28.1 ± 4.5
Normal weight (18.5–24.9 kg/m^2)	84 (17.4)	230 (27.7)	<0.001	21 (3.2)	293 (44.2)	<0.001	314 (23.9)
Overweight (25–29.9 kg/m^2)	260 (53.8)	357 (43.0)		281 (43.2)	336 (50.7)		617 (47.0)
Obese (≥30 kg/m^2)	139 (28.8)	244 (29.4)		349 (53.6)	34 (5.1)		383 (29.1)
Age (years)	57.9 ± 14.8	57.7 ± 14.9	0.836	61.1 ± 12.9	54.6 ± 16.0	<0.001	57.8 ± 14.9
20–44 years	103 (21.3)	161 (19.4)	0.311	87 (13.4)	177 (26.7)	<0.001	264 (20.1)
45–64 years	179 (37.1)	343 (41.3)		257 (39.5)	265 (40.0)		522 (39.7)
>64 years	201 (41.6)	327 (39.4)		307 (47.2)	221 (33.3)		528 (40.2)
Smoking (yes)	88 (18.2)	102 (12.3)	<0.01	73 (11.2)	117 (17.6)	<0.001	190 (14.5)
Drinking alcohol (yes)	299 (61.9)	335 (40.3)	<0.001	283 (43.5)	351 (52.9)	<0.001	634 (48.2)
Physical activity during spare time							
Sedentary	79 (16.4)	202 (24.3)	<0.001	143 (22.4)	135 (20.4)	<0.01	281 (21.4)
Smooth	137 (28.4)	302 (36.3)		240 (36.9)	199 (30.0)		439 (33.4)
Moderate + intensive	267 (55.3)	327 (39.4)		265 (40.7)	329 (49.6)		594 (45.2)
Achievement of the Dietary Guideline Score							
Very low (0–1)	72 (14.9)	77 (9.3)	<0.001	80 (12.3)	69 (10.4)	0.624	149 (11.3)
Low (2)	161 (33.3)	188 (22.6)		165 (25.3)	184 (52.7)		349 (26.6)
Middle (3)	179 (37.1)	378 (45.5)		277 (42.5)	280 (42.2)		557 (42.4)
High (4–5)	71 (14.7)	188 (22.6)		129 (19.8)	130 (19.6)		259 (19.7)
Unhealthy Habit Score							
Very low (0)	178 (36.9)	373 (44.9)	<0.01	277 (42.5)	274 (41.3)	0.393	551 (41.9)
Low (1)	139 (28.8)	238 (28.6)		196 (30.1)	181 (27.3)		377 (16.8)
Middle (2)	92 (19.0)	129 (15.5)		100 (15.4)	121 (18.3)		221 (16.8)
High (3–5)	74 (15.3)	91 (11.0)		78 (12.0)	87 (13.1)		165 (12.6)
Meal intake behaviour (yes)							
Intake of all the three main meals	448 (92.8)	787 (94.7)	0.151	619 (95.1)	616 (92.9)	0.097	1235 (94.0)
Intake of							
Breakfast	460 (95.2)	805 (96.9)	0.132	632 (97.1)	633 (95.5)	0.124	1265 (96.3)
Forenoon meal	158 (32.7)	326 (39.2)	<0.05	233 (35.8)	251 (37.9)	0.437	484 (36.8)
Lunch	480 (36.8)	823 (99.0)	0.512	647 (99.4)	656 (98.9)	0.380	1303 (99.2)
Afternoon meal	166 (34.4)	432 (52.0)	<0.001	281 (43.2)	317 (47.8)	0.091	598 (45.5)
Dinner	470 (97.3)	816 (98.2)	0.283	641 (98.5)	645 (97.3)	0.139	1286 (97.9)
Snacking	109 (22.6)	220 (26.5)	0.115	178 (27.3)	151 (22.8)	0.056	329 (25.0)

[a] Categories of BMI according to WHO (2000).
n, number; SD, standard deviation.

Table 2
OR (95% CI) for the MIB – the intake of the forenoon meal and afternoon meal and snacking between the participants' regularly taken meals – by sex, age, smoking, drinking alcohol and physical activity in leisure time, the intake of all the three main meals, the Achievement of the Dietary Guideline Score and Unhealthy Habit Score mutually adjusted by the MIB not considered to be the dependent variable in each regression.

	Having a forenoon meal	Having an afternoon meal	Snacking
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Sex (men)[a]	1.04 (0.79–1.37)	**0.57 (0.43–0.74)**	0.75 (0.56–1.01)
Age (years)	0.99 (0.98–1.00)	1.00 (0.99–1.01)	0.99 (0.98–1.00)
Smoking (yes)[a]	1.02 (0.69–1.49)	0.88 (0.60–1.29)	1.07 (0.73–1.56)
Drinking alcohol (yes)[a]	1.00 (0.77–1.29)	0.78 (0.61–1.01)	0.98 (0.74–1.29)
Physical activity during spare time[a]			
Smooth	1.27 (0.88–1.84)	0.94 (0.65–1.35)	0.77 (0.53–1.11)
Moderate + intensive	1.31 (0.92–1.87)	0.87 (0.61–1.24)	0.81 (0.57–1.16)
Realization of all the three main meals (yes)[a]	0.62 (0.37–1.06)	0.61 (0.36–1.05)	0.96 (0.56–1.65)
BMI (kg/m^2)	1.01 (0.99–1.04)	0.97 (0.94–1.00)	1.03 (1.00–1.06)
Achievement of the Dietary Guideline Score[a]			
Low (2)	1.34 (0.82–2.21)	**2.66 (1.59–4.43)**	1.50 (0.93–2.42)
Middle (3)	1.41 (0.86–2.30)	**4.18 (2.53–6.92)**	1.47 (0.91–2.36)
High (4–5)	**3.03(1.79–5.13)**	**3.76 (2.19–6.48)**	1.42 (0.84–2.40)
Unhealthy Diet Score[a]			
Low (1)	1.07 (0.78–1.45)	0.77 (0.57–1.05)	**2.21 (1.57–3.10)**
Middle (2)	1.32 (0.91–1.92)	0.71 (0.49–1.03)	**3.06 (2.08–4.50)**
High (3–5)	1.19 (0.76–1.86)	1.26 (0.80–1.97)	**5.51 (3.56–8.54)**
Having a forenoon meal[a]		**5.41 (4.17–7.01)**	1.17 (0.88–1.57)
Having an afternoon meal[a]	**5.42 (4.18–7.03)**		1.25 (0.93–1.68)
Snacking[a]	1.16 (0.86–1.56)	1.26 (0.94–1.69)	

[a] Reference categories (OR = 1): sex–women, smoking–no, alcohol consumption–no, physical activity in leisure time–sedentary, realization of all the three main meals–no, achievement of the Dietary Guideline Score–very low, Unhealthy Diet Score–very low, having a forenoon meal–no, having an afternoon meal–no, snacking–no.
Values in bold: $p < 0.05$.

contrast snacking between the regular meals did not remain associated positively after the adjustment for BMI. Men were less likely to experience AO than women, whereas age and BMI were positively associated with the risk factor. Moderate and intensive physical activity decreased the probability of AO but the association did not hold after adjusting for BMI. Compared to the very low category of the ADGS, the low, middle and high category decreased the risk of having AO. Whereas the higher category of the UHS compared to the very low one increased the risk, the association also did not remain after adjusting for BMI.

Discussion

The aim of the study was to investigate the associations between AO and several MIB such as the intake of the forenoon meal, the intake of the afternoon meal and snacking between the

Table 3
OR (95% CI) for AO by MIB.

	Model 1[a]	Model 2[b]	Model 3[c]	Model 4[d]	Model 5[e]
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Having a forenoon meal[f]	1.05 (0.81–1.37)	0.93 (0.64–1.35)	1.08 (0.83–1.41)	1.05 (0.81–1.37)	0.92 (0.63–1.34)
Having an afternoon meal[f]	**0.64 (0.49–0.82)**	**0.58 (0.40–0.84)**	**0.68 (0.52–0.88)**	**0.64 (0.49–0.83)**	**0.60 (0.41–0.88)**
Snacking[f]	**1.48 (1.13–1.95)**	1.37 (0.93–2.02)	**1.49 (1.13–1.96)**	**1.39 (1.05–1.85)**	1.25 (0.84–1.87)
Sex (men)[f]	**0.38 (0.29–0.49)**	**0.10 (0.07–0.15)**	**0.36 (0.28–0.47)**	**0.37 (0.28–0.48)**	**0.10 (0.06–0.14)**
Age (years)	**1.04 (1.03–1.05)**	**1.04 (1.02–1.05)**	**1.04 (1.03–1.05)**	**1.04 (1.03–1.05)**	**1.04 (1.03–1.06)**
Smoking (yes)[f]	0.88 (0.62–1.25)	1.53 (0.92–2.53)	0.85 (0.60–1.21)	0.85 (0.60–1.21)	1.47 (0.88–2.44)
Drinking alcohol (yes)[f]	0.85 (0.67–1.07)	0.84 (0.60–1.18)	0.84 (0.66–1.07)	0.85 (0.67–1.08)	0.83 (0.59–1.17)
Physical activity during spare time[f]					
Smooth	0.77 (0.55–1.08)	1.00 (0.62–1.62)	0.82 (0.58–1.16)	0.80 (0.57–1.13)	1.08 (0.66–1.76)
Moderate + intensive	**0.57 (0.41–0.79)**	0.91 (0.50–1.30)	**0.61 (0.43–0.85)**	**0.60 (0.43–0.83)**	0.88 (0.54–1.43)
Intake of all the three main meals (yes)[f]	1.19 (0.72–1.96)	0.67 (0.34–1.30)	1.34 (0.81–2.23)	1.24 (0.75–2.04)	0.78 (0.39–1.54)
BMI (kg/m^2)		**2.03 (1.87–2.20)**			**2.03 (1.87–2.20)**
Achievement of the Dietary Guideline Score[f]					
Low (2)			**0.61 (0.40–0.94)**		0.68 (0.37–1.24)
Middle (3)			**0.54 (0.36–0.83)**		0.62 (0.35–1.11)
High (4–5)			**0.54 (0.34–0.86)**		0.72 (0.38–1.38)
Unhealthy Diet Score[f]					
Low (1)				1.25 (0.94–1.67)	1.28 (0.85–1.93)
Middle (2)				1.10 (0.77–1.56)	1.36 (0.83–2.24)
High (3–5)				1.52 (1.00–2.32)	1.79 (0.97–3.31)

[a] Model 1: adjusted for sex, age, and individual risk factors (smoking, alcohol consumption, physical activity in leisure time), intake of all the three main meals.
[b] Model 2: Model 1 and BMI.
[c] Model 3: Model 1 and Achievement of the Dietary Guideline Score.
[d] Model 4: Model 1 and Unhealthy Habit Score.
[e] Model 5: Model 1 and BMI, Achievement of the Dietary Guideline Score, Unhealthy Habit Score.
[f] Reference categories (OR = 1): sex–women, smoking–no, alcohol consumption–no, physical activity in leisure time–sedentary, realization of all the three main meals–no, Achievement of the Dietary Guideline Score–very low, Unhealthy Diet Score–very low, having a forenoon meal–no, having an afternoon meal–no, snacking–no.
Values in bold: $p < 0.05$.

participants' regular meals, in order to analyse if these MIBs are able to decrease/increase the probability of AO. The results suggest that having an afternoon meal is negatively associated with AO, while snacking shows a positive relation. In contrast, the forenoon meal does not show any associations with AO. Whereas the association of the afternoon meal is robust to controls for confounders such as sex, age, individual risk factors, BMI, the intake of all the three main meals and independent of whether unhealthy habits are conducted (UHS) or dietary guidelines followed (ADGS), the association with snacking does not reach statistical significance after the analysis was adjusted for BMI. The forenoon and also the afternoon meal show positive association with the ADGS, whereas snacking is positively related with the UHS.

In contrast to other countries, five meals are undertaken regularly in Spain – breakfast, forenoon meal, lunch, afternoon meal and dinner. Perceiving the intake between the three main meals as meals rather than snacks has consequences over nutritional quality (Keller et al., 2014) and over the quantity consumed in the meals which follow, and may compensate for meals skipped, such as breakfast or lunch (Capaldi, Quinn, & Privitera, 2006; Wansink et al., 2010). The forenoon and afternoon meal are MIBs that are clearly underexplored, as studies about meal patterns do not usually differentiate within the meals or they take into account only the three main meals (Mesas et al., 2012), coding the rest of the eating occasions as snacking. Furthermore, due to the fact that the forenoon and afternoon meals are traditional meals within Spain, they are possibly less represented in other populations. Therefore, our findings are of significance as we have detected an association revealing that individuals who have an afternoon meal are less likely to be abdominally obese. This finding might be explained by the food consumed during this meal as the intake of the afternoon meal could promote a healthier diet as has been found in a previous study carried out by the authors (Keller et al., 2014). But our results indicate that the association between AO with the intake of the afternoon meal is independent from the ADGS. It seems that the fulfilment of dietary recommendations does not account for the associations. Another possible explanation might be that the afternoon meal – perceived as a meal – might affect the subsequent eating occasion. It has been shown that individuals who consider an eating occasion a meal rather than a snack consume less in the following eating occasion even though the food eaten was the same (Wadhera & Capaldi, 2012; Wansink et al., 2010). The meal following the afternoon meal is dinner, which might be a critical meal as most of the energy taken during the day is consumed in this late eating occasion (Howarth et al., 2007), which therefore has important metabolic consequences. The benefits occurring from a smaller intake during dinner might provoke the effects of the afternoon meal over AO (Jakubowicz, Barnea, Wainstein, & Froy, 2013; Scheer, Morris, & Shea, 2013).

Snacking – defined as eating occasions taken by the participants between their regular meals – shows a positive relation with AO, but this association is not independent of BMI. One study investigated the intake of several small amounts of food compared to the intake of three main meals and afternoon tea (Marín-Guerrero et al., 2008) and found associations with obesity in women independent of confounders. Several small amounts of food might lead to higher consumption of snack food (Wansink et al., 2010) as the constitution of snack food facilitates the intake of several small eating occasions (Hartmann, Siegrist, & van der Horstt, 2012). Snacking, as taken between the regular meals of the participants, might also favour the intake of small amounts of food and therefore explain the associations with AO. One study found that snacking was more prevalent within obese individuals and that it increased the total energy intake due to an increased energy intake from cake, cookies, candies and chocolate. This finding was consistent with another study investigating the change in waist circumference within five years with the intake of different food groups. An association was found with snack food like chocolates, sweets, potato chips and french fries (Halkjaer et al., 2009). In our study we found an association between the UHS and snacking, which shows that, compared to individuals with a very low intake of unhealthy food, individuals with an increased consumption are more likely to snack between the five main meals. The attenuation of the associations between AO and snacking through BMI might have its origin in the possible relation between BMI and snacking. Persons with a higher BMI could be more likely to snack as was found by the study of Bertéus Forslund, Torgerson, Sjöström, and Lindroos (2005), mentioned above. Moreover, our results also showed a marginally significant association between snacking and BMI.

We found that a low, middle and high ADGS in comparison with a very low one increased the possibility of having an afternoon meal. One could assume that it is the greater number of meals that increases the probability of achieving the recommendations assessed by the ADGS as the quantity of the food consumed increases with each eating occasion. But then snacking between the regular meals should demonstrate the same relation as the quantity of the food eaten also increases. However, no associations were found with the ADGS. Instead, snacking was associated positively with the UHS, indicating that this MIB might promote unhealthy habits. The consequence of this finding is of importance as it shows that it is not just the introduction of an additional eating occasion that might promote a healthier diet or decrease the risk of AO but the establishment of an eating occasion perceived and performed as a meal defined as in the Spanish context rather than a snack between one's regular meals.

Several limitations in this study need to be highlighted. First, the sample is not representative of the Spanish population as the individuals were not randomly selected. The "Semanas del Corazón" events are dedicated to the prevention of cardiovascular diseases, and thus people concerned with these issues might be more likely to voluntarily participate. For this reason, our findings cannot be generalized to the Spanish population, as the people of our sample might be more aware of their health-related behaviour. Another limitation is the cross-sectional design of the study, which limits the causal relationships, and only allows evaluation of the association between MIB and AO. Finally, the questionnaire used had not been validated by previous studies. However, the strengths of this study are the use of a questionnaire guided by a trained person and the direct measurements of waist circumference, weight and height, ensuring basic objectivity in the investigation and preventing errors of memory inexactness when remembering eating behaviour or response errors in self-reported measurements.

In conclusion, our study suggests that the intake of an afternoon meal decreases the probability of AO, independent of sex, age, lifestyle factors, BMI, the realization of all the three main meals, the consumption of unhealthy food and the achievement of dietary recommendations. The association found between the afternoon meal and AO is of special interest, as this MIB represents a traditional eating behaviour within the Spanish population. Therefore this result might be of importance for programmes preventing AO. Although the positive association of snacking between the participants' regular meals with AO is degraded by BMI, it should be taken into account by public health professionals as it is also associated with unhealthy eating behaviour. However, further prospective studies are needed in order to confirm the results of our cross-sectional study.

References

Alberti, K. G., Eckel, R. H., Grundy, S. M., Zimmet, P. Z., Cleeman, J. I., Donato, K. A., et al. (2009). Harmonizing the metabolic syndrome. A joint interim statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart

Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity. *Circulation*, *120*(16), 1640–1645.
Berg, C., Lappas, G., Wolk, A., Strandhagen, E., Torén, K., Rosengren, A., et al. (2009). Eating patterns and portion size associated with obesity in a Swedish population. *Appetite*, *52*(1), 21–26.
Bertéus Forslund, H., Torgerson, J. S., Sjöström, L., & Lindroos, A. K. (2005). Snacking frequency in relation to energy intake and food choices in obese men and women compared to a reference population. *International Journal of Obesity*, *29*(6), 711–719.
Capaldi, E. D., Quinn, J., & Privitera, G. J. (2006). Isocaloric meal and snack foods differentially affect eating behavior. *Appetite*, *46*, 117–123.
Deshmukh-Taskar, P., Nicklas, T. A., Radcliffe, J. D., O'Neil, C. E., & Liu, Y. (2012). The relationship of breakfast skipping and type of breakfast consumed with overweight/obesity, abdominal obesity, other cardiometabolic risk factors and the metabolic syndrome in young adults. The National Health and Nutrition Examination Survey (NHANES). *Public Health Nutrition*, *16*(11), 2073–2082.
Després, J. P. (2012). Body fat distribution and risk of cardiovascular disease. An update. *Circulation*, *126*(10), 1301–1313.
Gargallo Fernández, M., Quiles Izquierdo, J., Basulto Marset, J., Breton Lesmes, I., Formiguera Sala, X., & Salas-Salvadó, J. (2012). Evidence-based nutritional recommendations for the prevention and treatment of overweight and obesity in adults (FESNAD-SEEDO consensus document). The role of diet in obesity prevention (II/III). *Nutrición Hospitalaria*, *27*(3), 800–832.
Gigante, D. P., Barros, F. C., Post, C. L., & Olinto, M. T. (1997). Prevalence and risk factors of obesity in adults. *Revista de Saúde Pública*, *31*(3), 236–246.
Halkjaer, J., Tjønneland, A., Overvad, K., & Sørensen, T. I. A. (2009). Dietary predictors of 5-year changes in waist circumference. *Journal of the American Dietetic Association*, *109*(8), 1356–1366.
Hartmann, C., Siegrist, M., & van der Horstt, K. (2012). Snack frequency. Associations with healthy and unhealthy food choices. *Public Health Nutrition*, *16*(8), 1487–1496.
Holmbäck, I., Ericson, U., Gullberg, B., & Wirfält, E. (2010). A high eating frequency is associated with an overall healthy lifestyle in middle-aged men and women and reduced likelihood of general and central obesity in men. *The British Journal of Nutrition*, *104*(7), 1065–1073.
Howarth, N. C., Huang, T. T.-K., Roberts, S. B., Lin, B.-H., & McCrory, M. A. (2007). Eating patterns and dietary composition in relation to BMI in younger and older adults. *International Journal of Obesity*, *31*(4), 675–684.
Jakubowicz, D., Barnea, M., Wainstein, J., & Froy, O. (2013). High caloric intake at breakfast vs. dinner differentially influences weight loss of overweight and obese women. *Obesity*, *21*(12), 2504–2512.
Keller, K., Rodríguez López, S., Carmenate Moreno, M. M., & Acevedo Cantero, P. (2014). Associations between food consumption habits with meal intake behaviour in Spanish adults. *Appetite*, *83*, 63–68.
Kerver, J. M., Yang, E. J., Obayashi, S., Bianchi, L., & Song, W. O. (2006). Meal and snack patterns are associated with dietary intake of energy and nutrients in US adults. *Journal of the American Dietetic Association*, *106*(1), 46–53.
Ma, Y., Bertone, E., Stanek, E., Reed, G., Hebert, J., Cohen, N., et al. (2003). Association between eating patterns and obesity in a free-living US adult population. *American Journal of Epidemiology*, *158*(1), 85–92.
Marín-Guerrero, A. C., Gutiérrez-Fisac, J. L., Guallar-Castillón, P., Banegas, J. R., & Rodríguez-Artalejo, F. (2008). Eating behaviours and obesity in the adult population of Spain. *The British Journal of Nutrition*, *100*(5), 1142–1148.
Mesas, A., Muñoz-Pareja, M., López-García, E., & Rodríguez-Artalejo, F. (2012). Selected eating behaviours and excess body weight. A systematic review. *Obesity Reviews*, *13*(2), 106–135.
NCEP. (2001). Executive summary of the third report of the National Cholesterol Education Program (NCEP). Expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (adult treatment panel III). *JAMA: The Journal of the American Medical Association*, *85*(19), 2486–2497.
Popkin, B. M. (2001). Nutrition in transition. The changing global nutrition challenge. *Asia Pacific Journal of Clinical Nutrition*, *10*(Suppl.), S13–S18.
Salvador Castell, G., Mataix Verdú, J., & Serra-Majem, L. (2006). Grupos de Alimentos. In L. Serra-Majem (Ed.), *Nutrición y salud publica. Métodos, bases científicas y aplicaciones* (2nd ed., pp. 38–51). Barcelona, Spain: Masson, S.A.
Scheer, F. A. J. L., Morris, C. J., & Shea, S. A. (2013). The internal circadian clock increases hunger and appetite in the evening independent of food intake and other behaviors. *Obesity*, *21*(3), 421–423.
van der Heijden, A., Hu, F. B., Rimm, E. B., & van Dam, R. M. (2007). A prospective study of breakfast consumption and weight gain among U.S. men. *Obesity*, *15*, 2463–2469.
Wadhera, D., & Capaldi, E. D. (2012). Categorization of foods as "snack" and "meal" by college students. *Appetite*, *58*(3), 882–888.
Wansink, B., Payne, C. R., & Shimizu, M. (2010). "Is this a meal or snack?" Situational cues that drive perceptions. *Appetite*, *54*(1), 214–216.
Weiner, J. S., & Lourie, J. A. (1981). *Practical human biology* (1st ed.). London, GB: Academic Press Inc.
WHO. (2000). Obesity: Preventing and managing the global epidemic. Report of a WHO consultation. In *World Health Organ Tech Rep* (Vol. 894, pp. 1–253). Geneva: World Health Organisation.
WHO. (2008). *Waist circumference and waist-hip ratio. Report of a WHO expert consultation*. Geneva: World Health Organisation.
WMA (World Medical Association). (2013). Declaration of Helsinki. Ethical Principles for Medical Research Involving Human Subjects. 64th General Assembly. Fortaleza, Brasil.