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Breakfast Skipping and Body Mass Index among Adolescents in Greece: Whether an Association Exists Depends on How Breakfast Skipping Is Defined

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ABSTRACT

Many studies have found an association between breakfast skipping and either body mass index (BMI; calculated as kg/m²) or overweight/obesity among adolescents, but several studies have found no association. This cross-sectional study investigated the hypothesis that this discrepancy is partly due to three differences in methodology. First, some studies have examined BMI, but other studies have examined overweight/obesity. Second, some studies have controlled for potential confounders, but other studies have not. Third, different studies have used different definitions of breakfast skipping. This study examined both the relationship between breakfast skipping and BMI and the relationship between breakfast skipping and overweight/obesity, compared unadjusted results with results adjusted for potential confounders, and compared results for 24 definitions of breakfast skipping. The sample consisted of 811 students at high schools in Piraeus, Greece, who completed a questionnaire and had their height and weight measured. The results supported this hypothesis. First, fewer breakfast-skipping variables were associated with BMI than with overweight/obesity. Second, fewer associations were found when controlling than when not controlling for potential confounders. Third, fewer associations were found for variables corresponding to some definitions of breakfast skipping than for variables corresponding to other definitions.

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A large body of research indicates that breakfast eaters are more likely than breakfast skippers to enjoy a variety of benefits (1-4). These benefits include a higher intake of micronutrients and of dietary fiber (5), better academic performance and school attendance (6), and maybe enhanced memory function (7). Some studies have also found that, compared to breakfast eaters, breakfast skippers have higher rates of mortality (8,9) and of iron-deficiency anemia (10), higher total cholesterol levels (11,12), and (for women) more severe constipation (13) and more intense dysmenorrhea (14).

It is an open question whether the benefits enjoyed by breakfast eaters include a lower body mass index (BMI; calculated as kg/m²) and a lower rate of overweight or obesity (3,15). Many studies have found that, compared to breakfast eaters, breakfast skippers have a higher BMI (16-26) or a higher rate of overweight/obesity (27-43), but several other studies have found no association between breakfast skipping and BMI (10,12,14,44-46), overweight/obesity (47-49), or body weight (50-52). What explains this discrepancy in the results of the previous studies?

An interesting hypothesis is that the discrepancy is at least partly due to three differences in methodology. First, some studies have examined BMI, but other studies have examined overweight/obesity. Second, some studies have controlled for potential confounders, but other studies have not. Third, different studies have used different definitions of breakfast skipping (usually without explaining why a particular definition was chosen). The aim of the present study was to investigate this hypothesis by examining both the relationship between breakfast skipping and BMI and the relationship between breakfast skipping and overweight or obesity, by comparing unadjusted results with results adjusted for potential confounders, and by comparing results for a wide variety of definitions of breakfast skipping.

METHODS

Study Design and Participants

The study was cross-sectional. Because previous studies have found that BMI differences between breakfast eaters and breakfast skippers are rather small (19,23,24,26), and because a goal of the study was to control for several potential confounders, to achieve high statistical power (ie, a high probability to find an association given that an

association exists), it was decided to collect data from at least 800 participants (53). Because previous studies have found that adolescents have higher rates of breakfast skipping than children (18,22,23,54,55), and because adolescents are more likely than children to accurately complete a self-administered questionnaire, it was decided to have high school students as participants. The study was approved by the Greek Ministry of National Education and Religious Affairs, and by the Social and Behavioral Sciences Institutional Review Board of the University of Wisconsin-Madison. Data were collected between April and November 2006 by two assistants (trained by one of the authors) who visited (sometimes together and sometimes separately) a convenience sample of six (of the existing 20) public high schools in Piraeus, Greece. The schools were located in urban areas and represented both more and less affluent neighborhoods. In each classroom that they visited, the assistants distributed first a questionnaire to the students and asked them to complete it anonymously in 15 minutes. The assistants then used a stadiometer (model 38330; Metrica, San Donato Milanese, Italy) and a digital scale (model PW-2307; DeLonghi, Treviso, Italy) to take, in the classroom, a single measurement of the height and of the weight (with shoes) of each student who had agreed to participate. The assistants recorded the results of the measurements on the questionnaires, in centimeters for height and kilograms for weight.

Measures

Sex (male or female), ethnicity (Greek or non-Greek), smoking (yes or no), and dieting (yes or no) were determined by the questionnaire. Age was calculated by dividing the number of days between the date on which the questionnaire was completed and the date of birth indicated on the questionnaire by 365. BMI was calculated as kg/m^2 . Overweight or obesity (yes or no) was determined by using the age- and sex-specific BMI cut-off points proposed by the International Obesity Task Force (56). Physical activity was assessed with the question: "On average, how many days a week do you exercise (eg, weights, running, etc)?" The available answers were the integers from 0 to 7. Parental education (university/no university), a proxy for parental socioeconomic status, was defined as the maximum of paternal and maternal education. Breakfast skipping was defined in 24 different ways (Table 1), corresponding to breakfast consumption on the day of data collection, during the whole year, during the previous week, and on weekends/holidays. Age, weight, height, BMI, and physical activity were continuous variables; the remaining of the above variables were dichotomous.

Statistical Analyses

The analyses were performed with the statistical software SPSS for Windows (release 14.0.0, 2005, SPSS Inc, Chicago, IL). Cross-tabulations were used to determine, for each breakfast-skipping variable, the percentages of breakfast skippers according to sex, ethnicity, smoking, dieting, parental education, and overweight or obesity; χ^2 tests were used to determine statistically significant dif-

ferences. To determine the predictability of BMI from breakfast skipping, two linear regression models were used for each breakfast-skipping variable: an unadjusted (simple regression) model with BMI as the dependent variable and breakfast skipping as the only independent variable, and an adjusted (multiple regression) model in which sex, age, ethnicity, smoking, dieting, physical activity, and parental education were added (to breakfast skipping) as independent variables. Similarly, to determine the predictability of overweight or obesity from breakfast skipping, two logistic regression models (an unadjusted and an adjusted one) were used for each breakfast-skipping variable. All multiple (linear or logistic) regression analyses used forced entry: all predictors were forced into the models simultaneously. Cases were excluded listwise: if data for a participant were missing for a variable included in a model, the participant was excluded from the analyses for that model.

RESULTS AND DISCUSSION

Data were collected from a total of 842 students, but 31 questionnaires (3.7%) were excluded from the analyses because they were clearly incorrect or seriously incomplete (eg, important questions on breakfast consumption had not been answered). The final sample consisted of 811 participants (382 boys and 429 girls). Their ages ranged from 14.96 to 21.20 years (mean and median = 16.62 years), but 94.5% were younger than 18 years old. Mean BMI was 23.10. The rate of overweight or obesity was 28.1%, and the rate of obesity was 10.0%.

The percentages of breakfast skippers (Table 1) varied widely with the definition of breakfast skipping. At the lower end of the range, 3.6% of the participants never ate in the morning. This percentage is comparable to those found in previous studies (33,39). At the upper end of the range, 74.7% of the participants in this study ate at most six mornings a week. This percentage is much higher than those found in previous studies (14,20,39). This discrepancy is not altogether surprising: it is reasonable that the percentage of those who report not eating every morning (as in this study) should be higher than the percentage of those who report not having breakfast every morning (as in previous studies), because the former percentage (unlike the latter) includes those who, despite eating nothing, count themselves as having breakfast because they drink something (eg, milk or juice). This consideration suggests that care is needed when one compares percentages of breakfast skippers from different studies.

A first goal of this study was to investigate the hypothesis that it matters whether one examines the relationship between breakfast skipping and BMI or the relationship between breakfast skipping and overweight/obesity: of the 20 previous studies that examined the relationship between breakfast skipping and overweight/obesity (27-43,47-49), 17 found an association (27-43), but of the 18 previous studies that examined the relationship between breakfast skipping and BMI (10,12,14,16-26,41,44-46), only 12 found an association (16-26,41). The results of this study support this hypothesis and agree with the results of previous studies: a significant association ($P < 0.05$) between breakfast skipping and BMI was found in 29 out of the 48 linear regression models that were

used, but a significant association between breakfast skipping and overweight or obesity was found in 35 out of the 48 logistic regression models that were used (Table 2). Moreover, in 37 out of 48 cases the *P* value concerning overweight or obesity was lower than the corresponding *P* value concerning BMI.

A second goal of this study was to investigate the hypothesis that it matters whether one controls for potential confounders: some previous studies found an association when certain potential confounders were not controlled for, but not when they were controlled for (22,23,41). The results support this hypothesis: a significant association ($P < 0.05$) was found in 29 out of the 48 adjusted (linear or logistic regression) models but in 35 out of the 48 unadjusted models.

A third goal of this study was to investigate the hypothesis that it matters how one defines breakfast skipping: according to a recent review, “it is possible that the lack of a universal definition for breakfast and measurement of the breakfast meal has led to conflicting results in some cross-sectional and prospective studies assessing the association between breakfast and obesity” (15). The results support this hypothesis: many breakfast-skipping variables were significantly associated ($P < 0.05$) with BMI, but many others were not, and similarly for overweight or obesity (Table 2). All three variables corresponding to breakfast consumption on the day of data collection were significantly associated both with BMI and with overweight or obesity; this result agrees with the results of previous studies that used similar definitions of breakfast skipping (16,18,26,29,41), with one exception (45). On the other hand, there were few significant associations for the variables corresponding to breakfast consumption during the previous week. Maybe this is because participants could less accurately recall whether they had skipped breakfast during the previous week than on the day of data collection. Alternatively, the discrepancy may be due to the fact that the questions used to assess breakfast skipping during the previous week and on the day of data collection were worded differently (Table 1).

A limitation of this study is that the sample was not representative. A second limitation is that there is no information on nonparticipants; however, it is estimated that <2% of students declined to participate. A third limitation is that this study did not control for two potential confounders that previous studies have examined: daily energy intake and (ready-to-eat) cereal consumption. The omission of daily energy intake may not be very serious. This is because several studies have found that breakfast eaters have a higher daily energy intake than breakfast skippers (3,5,21,33,41,47,57); as a result, a significant association between breakfast skipping and BMI or overweight/obesity is unlikely to disappear when one controls for daily energy intake. The omission of (ready-to-eat) cereal consumption may be more serious. This is because some—though not all (3)—previous studies have found an inverse association between cereal consumption and BMI (23,26,41,58-60), and two studies have found that a significant association between breakfast skipping and BMI (23) or overweight or obesity (44) disappeared after controlling for cereal consumption (and other variables); as a result, it has been hypothesized that “it may be the content of breakfast (eg, cereal vs other foods) that

predicts BMI, not breakfast itself” (23). This hypothesis merits investigation in future research.

This is the first study to consider multiple definitions of breakfast skipping: no previous study has considered more than two definitions, and only three studies (20,40,49) have considered two definitions each. This is also the first study to examine breakfast skipping in relation to BMI and to overweight or obesity in Greece: a few previous studies have examined overweight or obesity in Greece, but not in relation to breakfast skipping. One of those studies (61) found much lower rates of overweight or obesity than the present study, but three other ones (62-64) found rates higher than those in the present study.

This study was cross-sectional, and thus cannot explain why an association between breakfast skipping and BMI exists (on certain definitions of breakfast skipping). Several possible explanations have been proposed. A first possibility is that the association is an artifact (65,66): several studies have found that obese people underreport their energy intake (66-68), so they may also underreport their breakfast consumption (34). In this study, however, two of the three breakfast-skipping variables corresponding to breakfast consumption on the day of data collection were significantly associated with BMI in the adjusted models even on the subsample of nonobese participants (results not shown). A second possibility is that having a higher BMI causes breakfast skipping via dieting (16,25,65,66): although dieting—in contrast to lack of time and not being hungry (36)—is infrequently given as a reason for breakfast skipping (69,70), several studies have found a significant association between dieting and breakfast skipping (70-76), especially for adolescent girls. Moreover, a recent longitudinal study found that dieting predicted decreased breakfast consumption in adolescent girls (77). The present study, however, did control for dieting, and another recent longitudinal study found that fewer days of breakfast consumption in adolescence and decreases in breakfast consumption between adolescence and adulthood predicted increased BMI in adulthood (78). A third possibility is that breakfast consumption causes having a lower BMI via reducing fat intake (45,59), increasing milk consumption and thus increasing calcium intake (23,59), or increasing cereal consumption and thus increasing fiber intake. As already noted, such a hypothesis merits investigation in future research. A fourth possibility is that breakfast consumption causes having a lower BMI via increasing satiety and thus decreasing energy intake later on in the day (15,16,78,79). (The fourth possibility is compatible with the third, because increasing fiber intake may increase satiety.) As already noted, however, several studies have found that breakfast eaters have a higher daily energy intake than breakfast skippers (although some of these findings may be due to the underreporting of energy intake by the obese). Finally, a fifth possibility is that the association between breakfast skipping and BMI is due to confounding by factors like physical activity, parental education, and smoking (4,15). Although several studies, including this one, did control for potential confounders, to exclude this possibility randomized studies are needed. The only previous randomized study (80) produced mixed results.

Table 1. Percentages of breakfast skippers according to sex, ethnicity, smoking, dieting, parental education, and overweight or obesity among 811 high school students in Piraeus, Greece^a

Definition of breakfast skipping	All (n=811)	Sex		Ethnicity		Smoking		Dieting		University Parental Education		Overweight or Obese	
		Male (n=382)	Female (n=429)	Greek (n=703)	Non-Greek (n=104)	No (n=530)	Yes (n=277)	No (n=612)	Yes (n=190)	No (n=486)	Yes (n=296)	No (n=566)	Yes (n=221)
Drank nothing this morning ^b	22.2	21.7	22.6	20.8*	30.8*	21.5	23.5	21.4	23.7	21.6	20.9	19.3**	29.4**
Ate nothing this morning ^b	39.1	44.2**	34.5**	39.7	34.6	41.1	35.7	37.3	45.3	38.9	39.5	35.9**	48.4**
Drank and ate nothing this morning ^b	12.5	14.1	11.0	11.7	16.3	13.4	10.8	10.8*	17.4*	11.5	12.5	9.7***	19.5***
On average eats 0 morning/week ^c	8.4	10.9*	6.2*	8.0	11.0	8.4	8.5	8.1	9.8	6.8	10.1	6.7*	12.0*
On average eats 0-1 morning/week ^c	13.5	16.0	11.2	12.9	17.0	14.0	12.5	12.8	16.4	11.7	15.6	10.9**	19.4**
On average eats 0-2 mornings/week ^c	28.2	31.3	25.5	27.6	31.0	29.2	26.2	27.5	31.1	27.4	28.5	23.3***	39.8***
On average eats 0-3 mornings/week ^c	37.8	40.8	35.2	37.3	40.0	37.8	37.6	36.1	43.2	37.2	37.8	32.4***	50.0***
On average eats 0-4 mornings/week ^c	48.0	47.0	48.8	46.9	54.0	48.0	48.0	47.3	50.3	48.0	46.9	43.8**	57.4**
On average eats 0-5 mornings/week ^c	61.3	59.2	63.1	60.5	66.0	60.0	63.5	60.2	64.5	63.1	57.3	57.8**	69.0**
On average eats 0-6 mornings/week ^c	74.7	72.0	77.1	74.0	80.0	75.4	73.1	73.2	78.7	74.9	73.3	72.5*	80.1*
On average never eats (in the morning) ^c	3.6	4.8	2.6	3.7	2.9	4.4	2.2	3.8	3.2	3.3	4.1	3.6	3.2
On average eats at most almost never ^c	12.5	12.7	12.2	11.8	16.5	12.8	12.0	12.0	13.9	12.9	11.5	11.1	14.2
On average eats at most very rarely ^c	20.9	21.8	20.2	20.4	24.3	22.4	18.5	19.8	24.6	22.3	16.9	18.2*	26.5*
On average eats at most rarely ^c	34.4	35.5	33.3	33.4	40.8	36.7	30.4	33.3	38.5	35.6	31.2	30.5**	43.4**
On average eats at most often ^c	49.9	48.5	51.2	49.6	52.4	51.8	46.4	48.6	54.0	50.8	47.5	46.3**	58.4**
Last week ate 0 morning ^d	3.6	5.0	2.3	4.0	1.0	3.4	4.0	3.6	3.2	3.3	4.1	3.0	5.0
Last week ate 0-1 morning ^d	5.9	8.1*	4.0*	6.4	2.9	6.0	5.8	6.2	4.7	5.8	6.4	5.3	7.2
Last week ate 0-2 mornings ^d	8.3	10.2	6.5	9.1*	2.9*	8.5	7.9	8.2	8.4	8.2	8.1	6.0***	14.0***
Last week ate 0-3 mornings ^d	11.8	14.7*	9.3*	12.5	7.7	11.7	12.3	11.8	11.6	12.3	10.8	10.2*	16.3*
Last week ate 0-4 mornings ^d	15.9	17.8	14.2	16.1	14.4	16.8	14.4	15.8	15.8	17.3	13.5	14.8	19.5

(continued)

Table 1. Percentages of breakfast skippers according to sex, ethnicity, smoking, dieting, parental education, and overweight or obesity among 811 high school students in Piraeus, Greece^a (continued)

Definition of breakfast skipping	All (n=811)	Sex		Ethnicity		Smoking		Dieting		University Parental Education		Overweight or Obese	
		Male (n=382)	Female (n=429)	Greek (n=703)	Non-Greek (n=104)	No (n=530)	Yes (n=277)	No (n=612)	Yes (n=190)	No (n=486)	Yes (n=296)	No (n=566)	Yes (n=221)
On weekends never eats (in the morning) ^e	4.1	2.9	5.2	3.6	7.8	4.6	3.3	3.0**	7.9**	4.5	3.1	2.8*	6.8*
On weekends eats at most very rarely ^e	14.3	13.7	14.8	13.7	18.6	14.4	14.1	11.8**	22.6**	14.7	12.6	11.6**	19.9**
On weekends eats at most rarely ^e	23.9	23.2	24.6	22.8	31.4	25.4	21.4	21.4**	33.2**	22.9	24.5	20.5**	32.1**
On weekends eats at most often ^e	45.2	43.2	47.1	44.4	51.0	46.7	42.4	42.3**	54.7**	45.5	44.2	40.4***	57.9***

^aEach entry in the table gives the percentage of those who count as breakfast skippers according to the row definition among the participants in the column subsample.

^bThe three definitions corresponding to breakfast consumption on the day of data collection were based on two (yes/no) questions: "From the moment you woke up this morning until now, have you drunk anything [question 1]/eaten any solid food [question 2]?" The three definitions corresponded to answering negatively question 1, question 2, and both.

^cThe 12 definitions corresponding to breakfast consumption during the whole year were based on two questions: "On average, taking into account all weeks of the year, how many days a week [question 3]/how often [question 4] do you eat in the morning?" The available answers for question 3 were the integers from 0 to 7, and for question 4 were "always," "almost always," "very often," "often," "rarely," "very rarely," "almost never," and "never." Seven definitions corresponded to answering question 3 with 0, 0 or 1, . . . , and 0 or . . . or 6, and five definitions corresponded to answering question 4 with "never," "never" or "almost never," . . . , and "never" or . . . or "often."

^dThe five definitions corresponding to breakfast consumption during the previous week were based on question 2 above and on the question: "Which of the last 6 days did you eat absolutely nothing in the morning? (Check all that apply.)" The available answers were: "yesterday," "the day before yesterday," . . . , and "6 days ago." The five definitions corresponded to having eaten something in the morning 0, 0 or 1, . . . , and 0 or . . . or 4 days during the previous week (including the day of data collection).

^eThe four definitions corresponding to breakfast consumption on weekends/holidays were based on the question: "On . . . vacations, holidays, weekends, . . . how often does it happen that you eat absolutely no solid food from the moment you wake up in the morning until the moment you start eating lunch?" The six available answers ranged from "you never eat" to "you always eat." The four definitions corresponded to never, at most very rarely (ie, never or very rarely), . . . , and at most often (ie, never or very rarely or rarely or often) eating something in the morning on weekends/holidays.

* $P < 0.05$.

** $P < 0.01$.

*** $P < 0.001$.

Table 2. Predictability of body mass index and of overweight or obesity from breakfast skipping for the full sample of 811 high school students in Piraeus, Greece

Definition of breakfast skipping	BMI ^a (Linear Regression)						Overweight or Obesity (Logistic Regression)					
	Means ^b		Unadjusted Models		Adjusted Models ^c		Unadjusted Models			Adjusted Models ^c		
	Eaters	Skippers	$\beta \pm SE^d$	<i>P</i> value ^e	$\beta \pm SE^d$	<i>P</i> value ^e	OR ^f	95% CI ^g	<i>P</i> value ^e	OR ^f	95% CI ^g	<i>P</i> value ^e
Drank nothing this morning	22.82	24.07	1.25±0.37	0.001*	1.32±0.38	<0.001*	1.75	(1.22-2.50)	0.002*	1.97	(1.32-2.95)	0.001*
Ate nothing this morning	22.72	23.68	0.96±0.32	0.003*	0.69±0.32	0.031*	1.68	(1.23-2.30)	0.001*	1.56	(1.10-2.21)	0.012*
Drank and ate nothing this morning	22.89	24.56	1.68±0.47	<0.001*	1.36±0.49	0.005*	2.24	(1.45-3.46)	<0.001*	2.29	(1.38-3.77)	0.001*
On average eats 0 morning/week	23.02	23.93	0.91±0.57	0.114	0.61±0.58	0.292	1.90	(1.12-3.22)	0.018*	1.70	(0.94-3.08)	0.081
On average eats 0-1 morning/week	22.95	24.08	1.14±0.47	0.015*	0.78±0.47	0.095	1.97	(1.28-3.03)	0.002*	1.84	(1.14-2.97)	0.013*
On average eats 0-2 mornings/week	22.77	23.95	1.18±0.35	0.001*	0.99±0.35	0.005*	2.18	(1.56-3.05)	<0.001*	2.14	(1.47-3.11)	<0.001*
On average eats 0-3 mornings/week	22.67	23.80	1.13±0.33	0.001*	0.95±0.33	0.004*	2.09	(1.52-2.88)	<0.001*	1.95	(1.37-2.79)	<0.001*
On average eats 0-4 mornings/week	22.75	23.48	0.73±0.32	0.022*	0.79±0.32	0.013*	1.73	(1.26-2.38)	0.001*	1.84	(1.29-2.63)	0.001*
On average eats 0-5 mornings/week	22.68	23.36	0.68±0.33	0.038*	0.68±0.33	0.036*	1.62	(1.16-2.27)	0.005*	1.66	(1.15-2.40)	0.007*
On average eats 0-6 mornings/week	22.55	23.28	0.74±0.37	0.044*	0.68±0.36	0.059	1.52	(1.04-2.23)	0.031*	1.55	(1.03-2.34)	0.038*
On average never eats (in the morning)	23.07	23.43	0.35±0.84	0.673	0.47±0.84	0.575	0.89	(0.37-2.14)	0.797	0.83	(0.33-2.15)	0.707
On average eats at most almost never	22.99	23.73	0.73±0.47	0.123	0.86±0.48	0.070	1.32	(0.83-2.10)	0.234	1.40	(0.85-2.32)	0.190
On average eats at most very rarely	22.91	23.73	0.82±0.38	0.034*	0.77±0.39	0.048*	1.62	(1.12-2.34)	0.011*	1.62	(1.08-2.44)	0.020*
On average eats at most rarely	22.81	23.61	0.80±0.33	0.015*	0.71±0.33	0.032*	1.74	(1.26-2.41)	0.001*	1.81	(1.26-2.58)	0.001*
On average eats at most often	22.68	23.50	0.82±0.31	0.009*	0.86±0.31	0.006*	1.64	(1.19-2.24)	0.002*	1.74	(1.23-2.47)	0.002*
Last week ate 0 morning	23.06	23.96	0.89±0.84	0.288	0.39±0.82	0.636	1.69	(0.78-3.67)	0.184	1.36	(0.59-3.13)	0.469
Last week ate 0-1 morning	23.07	23.56	0.49±0.66	0.457	0.21±0.65	0.743	1.39	(0.74-2.61)	0.299	1.19	(0.60-2.35)	0.622
Last week ate 0-2 mornings	22.99	24.25	1.26±0.56	0.026*	0.92±0.56	0.104	2.55	(1.53-4.27)	<0.001*	2.17	(1.24-3.82)	0.007*
Last week ate 0-3 mornings	23.02	23.68	0.66±0.48	0.171	0.44±0.48	0.356	1.70	(1.09-2.67)	0.020*	1.53	(0.93-2.50)	0.094
Last week ate 0-4 mornings	23.09	23.12	0.03±0.43	0.940	-0.07±0.42	0.864	1.39	(0.92-2.08)	0.115	1.30	(0.83-2.04)	0.254

(continued)

Table 2. Predictability of body mass index and of overweight or obesity from breakfast skipping for the full sample of 811 high school students in Piraeus, Greece (continued)

Definition of breakfast skipping	Means ^b		BMI ^a (Linear Regression)				Overweight or Obesity (Logistic Regression)					
	Eaters	Skippers	Unadjusted Models		Adjusted Models ^c		Unadjusted Models		Adjusted Models ^c			
			$\beta \pm SE^d$	P value ^e	$\beta \pm SE^d$	P value ^e	OR ^f	95% CI ^g	P value ^e	OR ^f	95% CI ^g	P value ^e
On weekends never eats (in the morning)	23.06	24.30	1.24 ± 0.79	0.117	0.58 ± 0.82	0.478	2.49	(1.21-5.12)	0.014*	2.14	(0.93-4.93)	0.075
On weekends eats at most very rarely	22.89	24.44	1.54 ± 0.44	0.001*	0.97 ± 0.45	0.033*	1.90	(1.25-2.89)	0.003*	1.62	(1.01-2.59)	0.045*
On weekends eats at most rarely	22.83	24.03	1.20 ± 1.36	0.001*	0.82 ± 0.37	0.026*	1.84	(1.30-2.61)	0.001*	1.79	(1.21-2.64)	0.003*
On weekends eats at most often	22.56	23.79	1.23 ± 0.31	<0.001*	0.87 ± 0.31	0.005*	2.03	(1.48-2.79)	<0.001*	1.96	(1.39-2.77)	<0.001*

^aBMI = body mass index; calculated as kg/m².

^bMean BMI for breakfast eaters and for breakfast skippers.

^cAdjusted for sex, age, ethnicity, smoking, dieting, physical activity, and parental education.

^d β is the unstandardized regression coefficient for breakfast skipping; SE is the standard error for β .

^eP values are based on the t statistic for linear regression and on the Wald statistic for logistic regression.

^fOR = Odds ratio for breakfast skipping (reference: breakfast eaters).

^gCI = Confidence interval for OR.

*P < 0.05.

CONCLUSIONS

The results of this study support the conclusion that whether an association between breakfast skipping and BMI exists depends on how breakfast skipping is defined, and similarly for an association between breakfast skipping and overweight or obesity. The results of this study also support the conclusion that researchers are more likely to detect an association if they use the dichotomous variable overweight or obesity than if they use the continuous variable BMI. If these results are borne out by replications, they can help detect robust associations, which future studies can try to explain.

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