



Factors Influencing Physical Activity Patterns in Obese and Non-Obese Children: Results from OBEY-AD Study

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Abstract

Objectives: The aim of the present study was to analyze patterns of Physical Activity (PA), concentrating on evaluating dietary patterns according with PA levels, in underweight/normal weight and overweight/obese (OWO) children across three geographical areas worldwide.

Methods: OBEY-AD is an international study enrolling 2720 children aged 3-11 years from school settings of metropolitan areas in South America (Mexico, Chile, Argentina, Brazil), Europe (Italy, France, United Kingdom, Germany, Georgia), and Asia (India). Children underwent anthropometric assessment. Dietary patterns and lifestyle were investigated through a cultural specific investigation tool administered to children's parents.

Results: Most of underweight/normal weight and OWO children did physical activity at least once a week or every day. OWO children who did PA at least once a week and every day showed slightly better dietary patterns compared who did PA rarely. Regarding underweight/normal weight children, those more physically active were more likely to eat more frequently fruits (p-value<0.001), vegetables (p-value<0.001), and meat (p-value<0.001). However, they ate slightly more frequently fried food, sweet and salty snacks (p-value<0.001). Interestingly, parent's perception of a quality diet (in terms of pleasant family mealtimes and varied diet) seemed to influence PA in both OWO and underweight/normal weight children.

Conclusions: Interestingly, parental perception of healthy diet may result in better PA patterns. However, it should be further analyzed what it means for families the concept of "varied and healthy diet" in order to understand if it really corresponds to the one proposed by international guidelines.

Keywords: Physical activity; Children; Parental perception; Nutrition; Obesity; South America; India; Europe

Introduction

Physical Activity (PA) has been demonstrated to result in beneficial health outcomes in both children and adolescents [1]. Several studies conducted in schoolchildren and young adults have shown that PA seems to be associated with better lipid profile [2], reduced risk of hypertension [2] and of metabolic syndrome [3] (characterized by insulin resistance, impaired blood lipid profile, abdominal obesity, and increased inflammatory markers). Additionally, it appears to contribute to the maintenance of a healthy musculoskeletal system, especially of healthy bones [4,5] (generally evaluated by assessing bone mineral density). Not least, PA has shown to result in better psychosocial outcomes (in terms of reduced risk of anxiety, depression, and better school performance) [6,7]. Above all potential PA benefits, its relationship with overweight/obesity has been extensively studied and debated [8,9], showing that PA seems to be relevant in overweight/obesity prevention and treatment [10].

In the last decades, obesity prevention and treatment has become a priority from the public health perspective. This is because it is associated with metabolic and cardiovascular impairments in early adulthood [11].

Deep characterizing patterns of PA in overweight/obese kids, identifying factors contributing (and main barriers) to exercise performance, is crucial to implement public health policies targeted on these factors, in order to promote PA. Several studies have revised evidence on determinants of PA in children and adolescents [12-17]. Biologic and socio-demographic factors appear to be associated with PA levels, especially male gender has found to be in a positive relationship with PA, while no definitive evidence has been reported on family's structure, and anthropometrics [13]. Among psychosocial factors, perceived self-efficacy appears to be associated with PA [13]. Also environmental factors, such as traffic, walkability, and availability of recreational facilities have been recently suggested to be related with PA levels [13]. Concerning behavioral factors, PA seems to be associated with healthier eating habits [15] (e.g., regular breakfast consumption, higher intake of fruits and vegetables), while its relationship with sedentary behaviors (TV watching and videogames playing) has not been established clearly [12,14].

Although determinants of PA have been extensively analyzed, studies on this topic focus rarely on overweight/obese children. Moreover, they have been conducted mainly in developed countries (where obesity trends seem to have stabilized [18]) even though, it is well known that childhood obesity epidemic is dramatically increasing especially in newly industrialized ones, and that PA patterns and their correlates may be country-specific due to cultural influences [13].

The aim of the present study was to analyze patterns of PA, concentrating on evaluating dietary patterns according with PA levels, in underweight/normal weight and overweight/obese (OWO) children across three geographical areas worldwide.

Materials and Methods

OBEY-AD is an international study enrolling 2720 children aged 3-11 years from school settings of metropolitan areas in: South America (Mexico, Chile, Argentina, Brazil), Europe (Italy, France, United Kingdom, Germany, Georgia), and Asia (India).

Children suffering of cognitive disorders, metabolic diseases, or allergies were excluded from the study. Parents were asked to provide inform consent prior to children participation to the study. Appropriate permissions were obtained by Institutional Review Boards. Detailed description of the study is given elsewhere [19].

Anthropometrics

Children were weighted and measured barefoot and wearing light clothes, using a body meter and an electronic stand-up balance scale. Measurements were taken with children’s back against the wall, paying attention to have the back of the feet touching the wall and to form a straight angle between the wall and the floor. BMI was calculated as weight (kg) divided by height (m) squared. World Health Organization (WHO) 2007 growth charts for children aged 5–19 [20] and WHO Multi center Growth Reference Study (MGRS) [21] for those aged 0–5 were employed to calculate BMI z-scores and categorize them in: a) underweight: $z\text{-BMI} < -2$; b) normal weight: $-2 < z\text{-BMI} < 1$; overweight: $1 < z\text{-BMI} < 2$; obese: $z\text{-BMI} > 2$. For the purpose of the study, children were distinguished in underweight/normal weight vs. OWO.

Study questionnaire

Dietary patterns and lifestyle were investigated through a cultural specific investigation tool, which was administered to children’s parents. The questionnaire was organized in four main sections. The first one aimed at assessing family’s socio-demographic characteristics, anthropometrics, and habits (family structure, parents’ education and working status, family members’ anthropometrics and physical activity levels). The second one assessed child’s dietary patterns (meal frequency and food consumption), and mother’s feeding practices. The third part evaluated mother’s perception of child’s body weight through

a projective test, and the last one assessed children’s physical activity (frequency and duration of each training session).

Children’s brand awareness was assessed using the IBAI (International Brand Awareness Instrument) questionnaire. A detailed description of the instrument is given elsewhere [22].

Statistical analysis

Continuous variables were reported as median (I and III quartiles), categorical as percentages (absolute number). Wilcoxon and Pearson’s chi-squared tests were performed whenever appropriate.

Statistical analyses have been performed using R system [23] and rms library [24].

Results

Seven hundred seventy-four children were found to be OWO. They were found to be older than underweight/normal weight kids (median age of 7 years in OWO vs. 6 years in underweight/normal weights, p-value 0.002) and more likely to be boys (55% of boys were OWO vs. 45% of girls, p-value 0.002). South America was found to be the geographical area with the highest proportion of OWO kids (40% vs. 35% in Europe, and 23% in India). Referring to PA frequency (at least once a week, every day, rarely), only a small proportion of underweight/normal weight and OWO kids reported to do PA rarely (23% of underweight/normal weight and 19% of OWO children).

Eating patterns have been analyzed according with PA levels in OWO (Table 1) and underweight/normal weight (Table 2) children. OWO children were more likely to have breakfast (p-value 0.054, barely significant), and morning snack (p-value 0.003) (Table 1).

	At least once a week (N=400)	Every day (N=224)	Rarely (N=150)	P-value
Dietary patterns				
Weekly fish consumption	1 [1;2]	2 [1;2]	2 [1;3]	0.275
Weekly meat consumption	3 [2;4]	3 [2;4]	2 [1;4]	0.257
Weekly soups and pottages consumption	2 [1;3]	2 [1;3]	2 [2;3]	0.522
Weekly high-protein vegetables consumption	2 [1;3]	2 [1;3]	2 [1;2]	0.042
Usual breakfast: Yes	88% (353)	82% (184)	82% (123)	0.054
Usual morning snack: Yes	45% (179)	54% (122)	37% (55)	0.003
Usual lunch: Yes	98% (391)	98% (220)	98% (147)	0.924
Usual afternoon snack: Yes	69% (277)	66% (148)	63% (95)	0.385
Usual dinner: Yes	97% (389)	97% (217)	95% (142)	0.317
Daily fruits servings : 1	44% (176)	49% (109)	51% (76)	0.03
2	32% (128)	27% (60)	25% (37)	
3	10% (40)	9% (20)	5% (7)	
4	2% (9)	1% (3)	3% (4)	
more than 4	2% (8)	7% (15)	4% (6)	

no one	10% (39)	8% (17)	13% (20)	
Daily vegetables servings : 1	37% (147)	35% (78)	37% (55)	0.318
2	36% (145)	30% (67)	33% (50)	
3	13% (53)	12% (27)	14% (21)	
4	2% (8)	2% (5)	3% (4)	
more than 4	3% (13)	4% (10)	3% (5)	
no one	8% (34)	17% (37)	10% (15)	
Salty snacks: at least once a week	14% (53)	11% (24)	13% (19)	0.006
more than once a day	7% (27)	10% (22)	11% (16)	
never	8% (33)	8% (16)	10% (15)	
once a day	16% (61)	29% (61)	18% (26)	
rarely	55% (215)	42% (89)	48% (70)	
Candies and chocolate: at least once a day	13% (52)	16% (34)	10% (15)	0.468
at least once a week	16% (64)	15% (32)	15% (22)	
more than once a day	1% (2)	0% (0)	1% (1)	
never	2% (7)	3% (6)	4% (6)	
once a day	29% (114)	35% (72)	34% (49)	
rarely	38% (149)	31% (64)	36% (53)	
Carbonated beverages: at least once a week	10% (37)	13% (26)	9% (13)	0.095
more than once a day	8% (29)	13% (26)	5% (7)	
never	17% (63)	15% (30)	24% (34)	
once a day	13% (48)	14% (28)	15% (21)	
rarely	51% (187)	45% (91)	46% (64)	
Cookies: at least once a week	13% (49)	14% (29)	8% (12)	0.165
more than once a day	11% (42)	17% (34)	14% (20)	
never	7% (26)	5% (11)	11% (16)	
once a day	39% (149)	37% (76)	34% (50)	
rarely	30% (114)	26% (53)	32% (47)	
Sweet snacks: at least once a week	12% (45)	11% (23)	16% (22)	0.21
more than once a day	0% (0)	0% (1)	1% (1)	
more than once a week	14% (50)	16% (33)	12% (17)	
never	12% (44)	11% (23)	17% (24)	
once a day	2% (9)	0% (0)	1% (2)	
once a week	12% (46)	17% (34)	11% (16)	
rarely	48% (176)	44% (90)	42% (59)	
Fried food: at least once a week	13% (50)	13% (26)	13% (18)	0.275

more than once a day	6% (21)	8% (17)	5% (7)	
never	10% (37)	8% (17)	13% (18)	
once a day	21% (77)	14% (29)	24% (34)	
rarely	51% (189)	56% (113)	46% (65)	
Mealtimes quality				
Eating the same foods : Never true	75% (139)	73% (73)	66% (53)	0.296
often true	8% (14)	4% (4)	6% (5)	
sometimes true	17% (32)	23% (23)	28% (22)	
Eating less than we should: Never true	88% (161)	87% (88)	91% (72)	0.177
often true	4% (8)	1% (1)	5% (4)	
sometimes true	8% (15)	12% (12)	4% (3)	
Providing balanced meals: Never true	83% (153)	84% (85)	89% (70)	0.567
often true	4% (8)	2% (2)	1% (1)	
sometimes true	12% (23)	14% (14)	10% (8)	
Weekly number of meals with the family	6 [2,7]	7 [3;7]	6 [2;7]	0.595
Mealtimes with the child: always pleasant	45% (179)	64% (132)	45% (65)	<0.001
never pleasant	0% (0)	0% (0)	0% (0)	
sometimes pleasant	9% (37)	9% (18)	13% (19)	
usually pleasant	46% (181)	28% (57)	42% (61)	

Table 1: Eating habits of OWO children according to PA levels

Additionally, they were reported to eat fruit (p-value 0.03) more frequently than those who did PA rarely. However, who did PA more frequently was found to eat salty snacks more often than who did PA rarely (p-value 0.006). Concerning the quality of children's eating patterns perceived by parents, a higher proportion of parents of

children who did PA daily reported to have pleasant mealtimes with kids than the parents of children who did PA less frequently (64% vs. 45% of those who did PA at least once a week and 45% of those who did PA rarely, p-value<0.001).

	At least once a week (N=887)	Everyday (N=606)	Rarely (N=447)	P-value
Dietary patterns				
Weekly fish consumption	1 [1;2]	2 [1;2]	1 [1,2]	0.12
Weekly meat consumption	3 [1;4]	2 [1;4]	2 [1,3]	<0.001
Weekly soups and pottages consumption	2 [1;3]	2 [1;3]	2 [1;3]	0.244
Weekly high-protein vegetables consumption	2 [1;3]	2 [1;3]	2 [1;3]	0.415
Usual breakfast: Yes	84% (742)	83% (504)	82% (366)	0.716
Usual morning snack: Yes	44% (391)	50% (302)	40% (180)	0.007
Usual lunch: Yes	98% (869)	98% (592)	98% (440)	0.695
Usual afternoon snack: Yes	67% (590)	61% (367)	60% (270)	0.023
Usual dinner: Yes	98% (865)	96% (581)	98% (438)	0.08

Daily fruits servings : 1	46% (407)	51% (310)	47% (212)	<0.001
2	32% (282)	24% (148)	27% (122)	
3	9% (82)	8% (47)	7% (30)	
4	3% (26)	3% (18)	2% (8)	
more than 4	3% (29)	5% (30)	3% (12)	
no one	7% (61)	9% (53)	14% (63)	
Daily vegetables servings 1	35% (309)	35% (211)	33% (148)	<0.001
2	37% (326)	30% (179)	32% (142)	
3	13% (113)	11% (69)	9% (41)	
4	5% (42)	4% (23)	4% (16)	
more than 4	3% (29)	5% (28)	7% (31)	
no one	8% (68)	16% (96)	15% (69)	
Salty snacks: at least once a week	11% (95)	8% (47)	7% (30)	<0.001
more than once a day	7% (57)	12% (69)	11% (46)	
never	9% (77)	7% (40)	8% (36)	
once a day	22% (187)	33% (189)	23% (101)	
rarely	52% (444)	40% (227)	51% (220)	
Candies and chocolate: at least once a day	16% (138)	18% (103)	19% (83)	<0.001
at least once a week	13% (115)	7% (40)	9% (37)	
more than once a day	0% (1)	0% (0)	0% (1)	
never	4% (31)	3% (17)	6% (25)	
once a day	33% (282)	42% (239)	35% (151)	
rarely	34% (288)	30% (170)	31% (135)	
Carbonated beverages: at least once a week	8% (68)	10% (52)	4% (15)	0.005
more than once a day	7% (60)	8% (42)	7% (27)	
never	20% (160)	24% (129)	28% (114)	
once a day	12% (100)	11% (62)	11% (44)	
rarely	52% (427)	48% (262)	51% (206)	
Cookies: at least once a week	10% (87)	11% (59)	9% (37)	0.19
more than once a day	12% (98)	12% (70)	17% (73)	
never	7% (61)	7% (37)	8% (35)	
once a day	37% (314)	40% (225)	36% (155)	
rarely	34% (283)	30% (169)	30% (130)	
Sweet snacks: at least once a week	14% (115)	16% (87)	8% (33)	0.012
more than once a day	0% (0)	0% (0)	0% (0)	
more than once a week	16% (134)	16% (88)	19% (80)	

never	11% (93)	12% (69)	14% (58)	
once a day	1% (5)	0% (1)	0% (0)	
once a week	14% (117)	15% (86)	12% (50)	
rarely	44% (360)	41% (227)	47% (193)	
Fried food: at least once a week	12% (101)	14% (75)	6% (26)	0.002
more than once a day	5% (45)	6% (31)	6% (25)	
never	8% (70)	9% (50)	13% (53)	
once a day	18% (146)	22% (122)	21% (88)	
rarely	56% (464)	50% (275)	53% (219)	
Mealtimes quality				
Eating the same foods : Never true	70% (378)	70% (274)	59% (196)	<0.001
often true	7% (37)	9% (35)	16% (52)	
sometimes true	23% (123)	21% (80)	25% (82)	
Eating less than we should: Never true	85% (455)	80% (308)	79% (257)	0.158
often true	4% (20)	6% (22)	6% (19)	
sometimes true	12% (62)	15% (56)	16% (51)	
Providing balanced meals: Never true	85% (455)	75% (288)	75% (247)	<0.001
often true	5% (26)	8% (30)	11% (36)	
sometimes true	10% (53)	17% (66)	14% (45)	
Weekly number of meals with the family	7 [3;7]	5 [3;7]	6 [2;7]	<0.001
Mealtimes with the child: always pleasant	41% (354)	52% (298)	42% (182)	<0.001
never pleasant	1% (6)	1% (5)	4% (17)	
sometimes pleasant	15% (126)	16% (91)	18% (80)	
usually pleasant	44% (378)	31% (176)	36% (157)	

Table 2: Eating habits of underweight/normal weight children according to PA levels

For underweight/normal weight children, those more physically active were more likely to eat more frequently fruits (p-value<0.001), vegetables (p-value<0.001), and meat (p-value<0.001) (Table 2). Regarding the quality of children's eating patterns who did PA every day was more likely to have pleasant mealtimes (p-value<0.001) with the family (p-value<0.001) and to have a varied diet (p-value<0.001). However, they ate slightly more frequently fried food and salty snacks (one third of children who did PA every day ate salty snacks daily vs. one fifth of those who did it less frequently, p-value<0.001), and to drink more often sodas.

Discussion

The present study aimed at assessing PA patterns of underweight/normal weight and OWO children, focusing on the association between PA levels and eating habits.

Obesity represents a severe burden worldwide, since it is associated with worse health outcomes. Lifestyle seems to play a key role in

obesity prevention and treatment. Among lifestyle factors, the relationship between PA and obesity has been widely analyzed and debated [8,9]. Recently, it has been supposed that obesity epidemic is not related to the decrease of energy expenditure, arguing the need of reformulating public health messages on obesity prevention [8]. Beyond the debate about the existence of an association between obesity epidemic and PA, the role of PA in contributing to better health outcomes is undisputable [1]. However, PA levels are found to be below than those recommended by international guidelines [25], and to decrease with age, especially in girls [26].

Approximately one fifth of both underweight/normal weight and OWO children reported to do PA rarely. Proportion of physically inactive OWO and underweight/normal weight children seems to be similar to that reported from literature [27]. However, it's difficult to compare PA levels due to differences in methodological approaches adopted [28], referring especially to methods employed for PA assessment (self-reported or objectively measured using specific tools,

such as accelerometers), and differences in criteria used to categorize PA (e.g., vigorous vs. moderate).

Investigating factors associated with PA in children and adolescents is important, in order to develop ad hoc public health strategies to promote PA, given its well-known health benefits. Several factors have been described in literature to be associated with PA in children, including behavioral, environmental, psychosocial, and biological characteristics [12-17]. Moreover, it has been recently proposed that also genetics may contribute to PA [29,30].

The present study focused especially on the association of eating habits with PA. OWO children who did PA at least once a week or every day showed slightly better dietary patterns compared who did PA rarely; even if they were more likely to eat salty snacks (this could be related to the fact that these children were generally more likely to have snacks). Concerning underweight/normal weight children, those found to be more physically active, ate more often junk food (fried food, salty and sweet snacks). Our findings are consistent with literature, showing that adolescents reporting higher levels of PA have higher energy intake [31]. Additionally, it has been shown that parental perception of quality diet (in terms of pleasant family mealtimes and varied diet) was associated with higher levels of PA in both OWO and underweight/normal weight children. This finding is interesting, suggesting that also family's perception of healthy diet may result in better PA patterns. However, it should be further analyzed what it means for families the concept of "varied and healthy diet" in order to understand if it really corresponds to the one proposed by international guidelines.

Conclusion

The present study showed that most of both underweight/normal weight and OWO children did PA at least once a week. The analyses of eating habits according with PA levels showed that, generally, OWO children who did more often PA were slightly more likely to have healthier eating patterns. Interestingly, parent's perception of a quality diet seemed to influence PA in both OWO and underweight/normal weight children.

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