Obesity, Physical Activity and Traumatic Dental Injuries in Adolescents from East London

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest in relation to this work.

ABSTRACT

Background: Evidence on the interplay between obesity, physical activity and traumatic dental injuries (TDI) is still inconclusive and heavily based on cross-sectional studies. The aim of this study was to explore the interrelationship of obesity and physical activity at age 11-12 years with TDI at age 15-16-years among schoolchildren from East London.

Method: Data were analysed regarding 598 adolescents who participated in Phases I and III of the Research with East London Adolescents Community Health Survey (RELACHS), a longitudinal, school-based study of adolescents in East London. Participants reported their level of physical activity and their height and weight were measured to estimate Body Mass Index Z-scores (according to the UK growth reference) when they were 11-12 years old. Oral clinical examinations were conducted to assess TDI, overjet and lip coverage when participants were 15-16 years old. The associations of obesity and physical activity with TDI were evaluated in crude and adjusted models using binary logistic regression.

Results: Overall, 22.6% of adolescents were obese and 7.2% exercised for 7 hours or more a week at baseline, while 18.1% of adolescents had experienced TDI by age 15-16 years. Physical activity (7+hours/week) was significantly associated with TDI (odds ratio: 2.19; 95% confidence interval: 1.08-4.43) in the crude model. However, no significant associations were found between obesity and TDI (1.18; 95% CI: 0.72-1.93) or physical activity and TDI (1.96; 95% CI: 0.94-4.07) in adjusted models.

Conclusion: This study found no evidence of any associations of obesity and physical activity with TDI among adolescents from East London.

INTRODUCTION

Traumatic dental injuries (TDI) result from the complex interplay between environmental factors, human behaviour and oral characteristics (1, 2). Most research on the aetiology of TDI has focussed on specific factors even though they are often associated together to increase the risk of accidental injury resulting in TDI (1, 3). Obesity and physical activity are good examples of correlated exposures which have been suggested as independent risk factors for TDI (4, 5). Obesity results from the imbalance between energy intake from diet and energy dispended through exercise (6). Therefore, daily exercise is considered a key contributor to weight maintenance through higher levels of energy expenditure (7, 8).

A systematic review investigated the interrelationship between body mass index (BMI), physical activity and TDI. Of the 13 studies included, one was a case-control study (4), another a cross-sectional analysis of birth cohort data (9) and all others were cross-sectional studies. Due to the marked variation in reference standards for BMI and physical activity, inconsistencies between study outcomes and varying study sizes, the authors reported that the results were inconclusive to declare any true associations (10). More recently, a meta-analysis of 17 studies found that obese children were more susceptible to TDI than lean children (pooled odds ratio: 1.30; 95% confidence interval: 1.11-1.53). However, the overall conclusion of this review needs to be treated with caution, as all but one of the primary studies included in the review were cross-sectional. In addition, results extracted from primary studies were a mix of crude and adjusted data, with a marked level of heterogeneity between them (5). The only longitudinal study to date, included in the above review, was conducted in 785 13-year-olds of Karnataka, India (2.7% dropout rate). TDI was recorded four times annually over 3 years using Andreasen’s criteria while BMI was measured according to the Indian Association of Paediatrics standards. Obese/overweight children had 2.78 (95% CI 2.24-7.36) greater odds of having TDI (no reference group was stated) after adjustment for socioeconomic status, lip coverage, incisal overjet and previous history of trauma (11). No adjustment for participants’ levels of physical activity was attempted.

Although falls from physical activity are the most frequent cause of unintentional TDI (12), habitual leisure activities have also been suggested as a trauma-protective behaviour because they enhance motor skills to counteract falls (10). Interestingly, a few studies point out that obese individuals are likely to be sedentary and/or physically inactive (13, 14), which might be protective against TDI. However, they also have poorer motor skills to respond swiftly, which may increase the odds of the fall rate among them (13, 15). Therefore, the interrelationship between obesity, physical activity and TDI needs to be carefully considered. Obesity and physical activity can be potentially modifiable risk factors of TDI. If physical activity is directly linked to the healthy weight status, encouraging children to maximise their participation in sports or related activities may reduce or prevent obesity and obesity-related TDI. In addition, the impact of different degrees of physical activity on TDI should be assessed to identify the safety level of any activity. The aim of this study was to explore the interrelationship between obesity and physical activity at age 11-12 years and TDI at age 15-16 years among schoolchildren from East London.

METHODS

Study population

The Research with East London Adolescents Community Health Survey (RELACHS) is a longitudinal school-based study of a representative, ethnically diverse sample of adolescents attending 28 state secondary schools in East London, UK. The RELACHS included three cross-sectional surveys of adolescents from year 7 (11-12 years) in 2001 (phase I), year 9 (13-14 years) in 2003 (phase II), and year 11 (15-16 years) in 2005 (phase III). Adolescents were selected using a stratified two-stage cluster sampling in 2001. All 42 eligible schools in the boroughs of Hackney, Tower Hamlets and Newham were initially stratified by borough and school type (comprehensive, voluntary and other). Thirty schools were selected randomly and balanced to ensure representation by single- and mixed-sex. In each of the 28 schools that agreed to participate, two representative mixed ability classes from year 7 were selected (16). Ethical approval was obtained from the East London and City Local Research Ethics Committee. Written informed consent was sought from each school’s head teacher and from each adolescent. Parents were fully informed about the study and given the opportunity to opt out.

This secondary analysis used longitudinal data from RELACHS phases I and III to achieve temporal ordering between exposures (obesity and physical activity) and outcome (TDI). A power calculation based on a previous study, where 9% of obese/overweight children had TDI and the odds ratio for the association between obesity/overweight and TDI was 2.8, with a non-obese/obese ratio of 1.7 (11), indicated that a sample of 521 adolescents was the minimum size required to identify a difference in TDI between obese and normal weight children, with 80% power and 95% confidence level.

Variables selection

Participants' height and weight were measured barefoot and in light indoor clothing using a portable stadiometer (Leicester Portable Stadiometer, CMS Camden Ltd, London) and a pre-calibrated digital scale (Tanita Body Fat 300 electronic scales, Tanita UK, Yiewsley, Middlesex) by trained field researchers. Height and weight data were used to calculate BMI, which was expressed in Z-scores in accordance with the UK 1990 growth reference (17). BMI was grouped into three categories, namely normal weight (<85th centile), overweight (≥85th centile) and obese (≥95th centile) (18). Physical activity was self-reported using a question taken from previous national surveys (19, 20) and shown to be valid and reliable in adolescents (20). Participants were asked "outside school hours, how many hours a week do you usually exercise in your free time so much that you get out of breath or sweat?" with 6 response options (none, about half an hour, 1 hour, 2-3 hours, 4-6 hours and 7 hours or more). Responses were grouped as <1 hour/week, 2-6 hours/week and >7 hours/week (21).

A number of demographic, socioeconomic and clinical factors (increased overjet and lip coverage) were treated as co-variates. Ethnicity was self-assigned using an adaptation of the 2001 UK census categories, including 24 ethnic sub-categories grouped into 5 main groups (White, Asian, Black, Mixed and Other). Socioeconomic measures were parental employment (both employed, one unemployed, both unemployed), household overcrowding (>1.5 persons/room) and family car ownership. In addition, adolescents' eligibility for free school meals was obtained from school records. It has been previously shown that parental employment was the most sensitive socioeconomic measure of the four assessed in this sample (22, 23). Therefore, only this measure was used during analysis.

Oral clinical examinations were conducted following the protocol of the World Health Organization (WHO) (24), except for the criteria to assess TDI. Two trained and calibrated examiners (GS and PE) carried out the oral clinical examinations with participants seated on an adjustable chair. Participants' teeth were not brushed or professionally cleaned prior to examination. Teeth were dried with cotton pellets and examined with plane mouth mirrors under illumination by Daray X100 examination lamps (Daray® Medical, Derbyshire, UK). Diagnosis was based on visual examination only and no radiographs were taken. TDI were recorded according to the classification described by Glendor et al. (12). Examiners were trained and calibrated before the main survey. At the end of this exercise, Kappa values for intra-examiner reliability were 0.87 and 0.91 and 0.80 for inter-examiner reliability. Overjet and lip coverage were also measured during clinical examinations. Overjet was recorded as increased if it was greater than 6 mm and lip coverage was recorded as inadequate if the lips were not in contact during rest position (25, 26).

Data analysis

Data were analysed using the Statistical Package for Social Sciences version 22 (IBM corporation, Armonk, New York). Firstly, the sociodemographic profile of the study sample (those who were followed up) were compared with that of the adolescents lost to follow-up, using the Chi-squared test. Next, levels of physical activity and BMI were compared by participants socio-demographic (sex, age, ethnicity and parental employment) and clinical characteristics (lip coverage and overjet) with the Chi-squared test.

The associations of obesity and physical activity with TDI were assessed in crude (labelled as Model 1A), adjusted (labelled as Models 2A and 2B) and mutually adjusted models (labelled as Model 3) using binary logistic regression since the outcome was a dichotomous variable. Odds ratios (OR) with 95% confidence intervals (CI) were therefore reported as the measure of association. The adjusted models controlled for the effect of socio-demographic and clinical characteristics whereas the mutually adjusted model additionally controlled for the other risk factor (physical activity or BMI).

RESULTS

A total of 1382 11-12-year-olds (83% response rate) and 1030 15-16-year-olds (71% response rate) participated in RELACHS phases I and III, respectively. Of the 975 pupils who had an oral examination in Phase III, 689 also participated in Phase I. Ninety one adolescents were excluded because of missing values in one or more variables. Table 1 shows the characteristics of the study sample. There were slighly more girls, Asians and children with at least one working parent in the study sample than in those excluded due to missing data. Overall, 23% were obese and 7.2% exercised 7 hours or more per week at age 11-12 years whereas the prevalence of TDI was 18.1% at age 15-16 years. Hardly any participants had increased overjet or inadequate lip coverage (9 and 3 participants, respectively).

No significant differences in obesity and physical activity levels were observed according to participants' characteristics, except between sexes (Table 2). The level of physical activity (7+hours/week) was significantly greater in male (10.8%) than female adolescents (4.1%). Differences in physical activity level by obesity or vice versa were not statistically significant either.

The results for the association between all baseline characteristics and TDI at follow-up are shown in Table 3. Due to the small number of cases, lip coverage was not included in these analyses. Physical activity (7+hours/week) was significantly associated with TDI at bivariate level (OR: 2.19; 95% CI: 1.08-4.43, p value: 0.029). However, the difference between adolescents exercising 7+hours/week and <1 hour/week was no longer significant after controlling for confounders. Greater, although not significant, odds of TDI were observed among obese adolescents (OR: 1.22; 95%CI: 0.75-1.98) than among normal weight adolescents. This estimate remained unchanged after adjusting for confounders. Only gender was positively associated with TDI; with females having lower odds of having TDI than males (OR: 0.62; 95% CI: 0.40-0.96).

DISCUSSION

This study offers little support for the associations of obesity and physical activity at age 11-12 years with TDI at age 15-16 years. Although adolescents who engaged in high levels of physical activity outside school hours (7+ hours/week) had more TDI four years later, these differences were accounted for by potential confounders (participants' demographic, socioeconomic and clinical characteristics). The association between BMI and TDI was not significant in either crude or adjusted models.

A number of arguments can be put forward to explain the non-significant findings before claiming there is no true interplay between obesity, physical activity and TDI. The first explanation could be the relatively small sample size, which was not purposefully estimated to explore the above associations. However, a post-hoc power calculation confirmed that the sample size was sufficient to test the hypothesised associations. It is worth noticing that the associations of obesity and physical activity with TDI in these adolescents were weak (especially for obesity), suggesting that even if significant results were obtained with larger samples, they may not be clinically meaningful compared to the effect of established risk factors for TDI. Interestingly, the crude odds ratio for obesity (1.22) was very similar to the pooled odds ratio (1.30) drawn mainly from unadjusted cross-sectional findings in a recent review (5).

The second explanation relates to measurement error in the exposures. Although standard and valid measures were used for obesity and physical activity, the latter was assessed using self-reports which are prone to measurement error (particularly recall and social desirability bias). This is in addition to the fact that only activities outside school hours were measured. Even though less variation in intensity and duration of physical activity occurs among adolescents during physical education classes, some students may be more active than others during free times at school (27). Objective measures that monitor energy expenditure can provide more comprehensive, quantitative assessments of physical activity. However, they also have limitations including technical, practical and interpretational issues (28). Therefore, questionnaires are still the dominant method of physical activity assessment in epidemiological surveys due to their low cost and relatively low participant burden (28, 29).

The third explanation relates to the age group selected for the study. There is evidence that physical activity decreases from early to late adolescence (30), with a subsequent reduction in the probability of having body injuries in general and TDI in particular. However, it was physical activity, not obesity, that was associated with TDI in the crude models. The odds ratio for the above association was attenuated only after adjusting for potential confounders.

This study has some implications. Negative findings are important because they challenge existing knowledge while proposing alternative explanations for the hypothesised associations that could be tested in further research. New longitudinal studies should include TDI assessments at both baseline and follow-up. Furthermore, studying the varying risks for each type of activity (sports-related, daily leisure, programmed exercise or other activities) related to falls, through a more comprehensive assessment of physical activity may merit attention. Alternatively, studying the risk of TDI in sedentary individuals can be an added advantage as this design would allow teasing out of the independent effects of obesity. From a policy point of view, more evidence is needed to disentangle the interplay between the three variables of interest. At this stage, it is too early to draw any policy recommendations.

This study also has some limitations. First, there were differences in the sociodemographic composition between the study sample and those excluded because of missing data. Therefore, the present findings represent valid relationships between the variables of interest but cannot be inferred to the entire study population. Second, this study did not include an assessment of TDI at baseline, needed to estimate TDI incidence over the four years studied. It is thus possible that some TDI occurred before the baseline assessment. Even without data on TDI incidence, this study is an improvement compared to previous studies based mainly on cross-sectional data. Third, TDI was recorded based on visible signs of trauma (12). Although diagnostic aids (radiographs, pulp sensibility tests or trans-illumination) are useful to identify root fractures and luxation injuries, they are rarely available in epidemiological surveys. Furthermore, injuries to the tooth-supporting structures are not included in the classification because they do not leave any visible markers. Therefore, the prevalence of TDI in this population is likely to be underestimated, which in turn could have affected the ability to identify significant associations. However, the prevalence of TDI in this study was higher than the 10% found among 15-year-olds in the nationwide Children's Dental Health Survey in 2013 (31).

In conclusion, this study did not offer any support for the interrelationship between obesity, physical activity and TDI among East London adolescents. A better understanding of this association is required before deriving any policy implications.

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Table 1. Characteristics of the study sample and comparison with the original sample of participants at baseline

Explanatory variables	Full sample (n=1382)		Study sample (n=598)	
	n	%	n	%
Sex				
Male	691	50.0%	278	46.5%
Female	691	50.0%	320	53.5%
Age				
11 years	441	32.1%	203	33.9%
12 years	931	67.9%	395	66.1%
Ethnicity				
White	386	28.6%	140	23.4%
Asian	542	40.1%	269	45.0%
Black	297	22.0%	136	22.7%
Mixed/Other	127	9.4%	53	8.9%
Parental Employment				
Both unemployed	465	35.4%	188	31.4%
At least one employed	847	64.6%	410	68.6%
Incisor overjet				
Up to 6mm	676	98.4%	589	98.5%
More than 6mm	11	1.6%	9	1.5%
Lip coverage				
Adequate	684	99.6%	595	99.5%
Inadequate	3	0.4%	3	0.5%
Physical activity				
≤1 hour/week	859	63.5%	382	63.9%
2-6 hours/week	405	30.0%	173	28.9%
7+ hours/week	88	6.5%	43	7.2%
Body Mass Index				
Normal	777	63.1%	383	64.0%
Overweight	165	13.4%	80	13.4%
Obese	289	23.5%	135	22.6%

Table 2. Physical activity (7+ hours/week) and obesity by participants' characteristics (n=598)

Explanatory variables	Physical activity		p value[a]	Obesity		p value[a]
	n	%		n	%	
Sex			0.002			0.078
Male	30	10.8%		72	25.9%	
Female	13	4.1%		63	19.7%	
Age			0.869			1.000
11 years	15	7.4%		46	22.7%	
12 years	28	7.1%		89	22.5%	
Ethnicity			0.072			0.843
White	17	12.1%		33	23.6%	
Asian	14	5.2%		57	21.2%	
Black	9	6.6%		31	22.8%	
Mixed/Other	3	5.7%		14	26.4%	
Parental employment			0.612			0.833
Both unemployed	15	8.0%		41	21.8%	
At least one employed	28	6.8%		94	22.9%	
Physical activity			--			0.706
≤1 hour/week	--	--		85	22.3%	
2-6 hours/week	--	--		42	24.3%	
7+ hours/week	--	--		8	18.6%	
Obesity			0.811			--
Normal	29	7.6%		--	--	
Overweight	6	7.5%		--	--	
Obese	8	5.9%		--	--	

[a] Chi-square test was used for comparison

Table 3. Associations of physical activity and obesity with traumatic dental injuries (TDI) (n=598)

Explanatory variables	% with TDI	Model 1[a]	Model 2A[a]	Model 2B[a]	Model 3[a]
		OR[b] [95% CI]	OR[b] [95% CI]	OR[b] [95% CI]	OR[b] [95% CI]
Sex					
Male	22.3%	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Female	14.4%	0.58 [0.38-0.89]*	0.61 [0.40-0.94]*	0.58 [0.38-0.89]*	0.62 [0.40-0.96]*
Age					
11 years	17.7%	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
12 years	18.2%	1.03 [0.66-1.66]	1.02 [0.65-1.60]	1.02 [0.65-1.60]	1.02 [0.65-1.60]
Ethnicity					
White	17.9%	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
Asians	17.5%	0.97 [0.57-1.66]	0.98 [0.56-1.71]	0.93 [0.53-1.61]	0.99 [0.56-1.74]
Black	16.9%	0.94 [0.50-1.74]	0.98 [0.52-1.85]	0.95 [0.50-1.79]	1.00 [0.53-1.89]
Mixed/Other	24.5%	1.49 [0.69-3.19]	1.56 [0.72-3.39]	1.45 [0.67-3.13]	1.53 [0.70-3.33]
Parental Employment					
Both unemployed	19.7%	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
At least one employed	17.3%	0.85 [0.55-1.33]	0.82 [0.52-1.30]	0.81 [0.51-1.29]	0.81 [0.51-1.29]
Incisor overjet					
Up to 6mm	18.2%	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]	1.00 [Reference]
More than 6mm	11.1%	0.56 [0.07-4.55]	0.49 [0.59-4.12]	0.47 [0.58-3.93]	0.51 [0.06-4.24]
Physical activity					
<1 hour/week	16.5%	1.00 [Reference]	1.00 [Reference]	---	1.00 [Reference]
2-6 hours/week	18.5%	1.14 [0.71-1.83]	1.10 [0.68-1.79]	---	1.10 [0.68-1.79]
7+ hours/week	30.2%	2.19 [1.08-4.43]*	1.92 [0.93-3.98]	---	1.96 [0.94-4.07]
Body mass index					
Normal	18.2%	1.00 [Reference]	---	1.00 [Reference]	1.00 [Reference]
Overweight	11.3%	0.56 [0.27-1.18]	---	0.56 [0.26-1.18]	0.56 [0.27-1.19]
Obese	21.4%	1.22 [0.75-1.98]	---	1.15 [0.70-1.89]	1.18 [0.72-1.93]
Model fit statistics[c]					
AIC			572.88	572.42	573.36

[a] Model 1 was unadjusted; Model 2A adjusted for sex, age, ethnicity, parental employment, incisor overjet and physical activity; Model 2B adjusted for sex, age, ethnicity, parental employment, incisor overjet and obesity; and Model 3 adjusted for sex, age, ethnicity, parental employment, incisor overjet, physical activity and obesity.
[b] Logistic regression was fitted and odds ratios (OR) reported.
[c] AIC: Akaike's Information Criterion. AIC values for the crude regression models of physical activity and body mass index were 566.45 and 567.03, respectively.
* $p<0.05$