

The association between BMI, vigorous physical activity and television viewing and the risk of symptoms of asthma, rhinoconjunctivitis and eczema in children and adolescents: ISAAC Phase Three

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Summary

Background Several studies have observed an association between obesity and asthma, but whether or not there is an association with rhinoconjunctivitis or eczema is unclear.

Aims To examine the relationship between body mass index categories (underweight, overweight and obesity), vigorous physical activity and television viewing and the risk of symptoms of asthma, rhinoconjunctivitis and eczema.

Methods As part of International Study of Asthma and Allergies in Childhood (ISAAC) Phase Three, parents or guardians of children aged 6–7 years completed written questionnaires about symptoms of asthma, rhinoconjunctivitis and eczema, and several potential risk factors, such as vigorous physical activity and television viewing, and other information such as the child's height and weight. Adolescents aged 13–14 years self-completed the questionnaires on these symptoms and potential risk factors and reported their own height and weight. For 28% of children and 24% of adolescents, the height and weight was objectively measured.

Results A total of 76 164 children aged 6–7 years (from 29 centres and 17 countries) and 201 370 adolescents aged 13–14 years (from 73 centres and 35 countries) provided data meeting the inclusion criteria. There were associations between overweight and obesity, but not underweight, and symptoms of asthma and eczema but not rhinoconjunctivitis. Vigorous physical activity was positively associated with symptoms of asthma, rhinoconjunctivitis and eczema in adolescents, but not children. Viewing television for five or more hours/day was associated with an increased risk of symptoms of asthma, rhinoconjunctivitis and eczema in adolescents and symptoms of asthma in children.

Conclusions and Clinical Relevance This study has confirmed the association between overweight and obesity and symptoms of asthma. It has extended these observations to include significant associations with symptoms of eczema, but not rhinoconjunctivitis. There are complex relationships between obesity, vigorous physical activity and sedentary behaviour and the symptoms of asthma, rhinoconjunctivitis and eczema in children.

Keywords asthma, body mass index, eczema, physical activity, rhinoconjunctivitis, television viewing

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Introduction

*Members of the ISAAC Phase Three Study Group are listed in Appendix 1.

Obesity and asthma and allergies are important health problems, and there is evidence that the prevalence of

these conditions have increased. Obesity is a known risk factor for cardiovascular disease and type 2 diabetes, and there is an increasing body of evidence indicating it is also a risk factor for asthma [1–7]. Many cross-sectional, case-control and prospective studies have reported an association between obesity and an increased risk of asthma [1–6]. Furthermore, obesity often antedates asthma. Some studies have found the association between obesity and asthma only in females [8–10], however, others have not [11]. Furthermore, there are some studies showing a relationship between being underweight and asthma, suggesting a U-shaped association between BMI and asthma [12–14].

Lack of exercise and sedentary behaviours, such as television viewing, are associated with obesity. A few studies have examined the association between lack of exercise and television viewing and the risk of asthma, but the results are conflicting. Some studies have reported associations of both low levels of physical activity [15, 16] and high levels of sedentary behaviour with asthma [17]. Others have reported an association between increased physical activity and asthma [18, 19]. A more recent study showed that duration of television viewing at 3.5 years was associated with subsequent asthma development at 11.5 years [20].

The association of obesity, lack of exercise and television viewing and the risk of rhinoconjunctivitis and eczema have rarely been examined. One study reported that there was no association between obesity and eczema in young adolescents [21] and another found no association with rhinoconjunctivitis in Swedish conscripts [22]. A recent report from Japan showed an association between obesity and asthma but not eczema and rhinoconjunctivitis in children [13].

The aim of this study was to examine the relationships between body mass index (BMI) categories (underweight, overweight and obesity), vigorous physical activity and television viewing and the risk of symptoms of asthma, rhinoconjunctivitis and eczema. We hypothesized that underweight, overweight and obesity, lack of vigorous physical activity and increased television viewing would be associated with symptoms of asthma, but not with symptoms of rhinoconjunctivitis and eczema.

Methods

International Study of Asthma and Allergies in Childhood (ISAAC) Phase Three is a multi-centre, multi-country, cross-sectional study of children (aged 6–7 years) and adolescents (aged 13–14 years) chosen from a random sample of schools in a defined geographical area [23]. The parent or guardian completed the questionnaire for the children, and for the adolescents the questionnaire was self-completed.

The questionnaire was in two parts. The first part ascertained the prevalence of symptoms of asthma, rhinoconjunctivitis and eczema. The second part asked about possible risk factors for the development of asthma and allergies. The questionnaire was translated into the local language with back translation into English [24].

Outcomes

Current wheeze was identified by a positive response to the question: 'Has your child/have you had wheezing or whistling in the chest in the past 12 months?'

Severe asthma symptoms were identified by fulfilling one or more of the following criteria:

- four or more attacks of wheezing in the past 12 months, or
- sleep disturbance due to wheezing occurring one or more nights per week in the past 12 months or
- wheezing limiting speech to one or two words at a time between breaths in the past 12 months.

Reported asthma was defined as a positive response to the question: 'Has your child/have you ever had asthma?'

Current rhinoconjunctivitis was identified by a positive response to each of the following questions:

- 'In the past 12 months has your child/have you had a problem with sneezing, or a runny or blocked nose when he/she did not have a cold or the flu?' and
- 'If yes, has this nose problem been accompanied by itchy watery eyes?'

Current eczema was identified by a positive answer to each of the following questions:

- 'Has your child/have you ever had an itchy skin rash, which was coming and going for at least 6 months?' and
- 'If yes, has your child/have you had this itchy rash at any time in the past 12 months?' and
- 'If yes, has this itchy rash at any time affected any of the following places – the folds of the elbows, behind the knees, in front of the ankles, under the buttocks, or around the neck, ears, or eyes?'

The prevalence of wheeze and asthma is higher in children with rhinoconjunctivitis and eczema [25], and with parents who smoke [26–32]. As this might account for associations between parental smoking and eczema and rhinoconjunctivitis, the risk of symptoms of eczema and rhinoconjunctivitis in the absence of current asthma symptoms was also examined.

In addition, a video questionnaire of asthma symptoms was administered to the adolescents. The video asthma question used was the sequence on wheeze at

rest. Current wheeze (video) was defined as a positive response to the question: 'Has your breathing been like this in the past year?' The video asthma questionnaire was validated against the written questionnaire [33].

Explanatory variables

In some centres, the subjects' height and weight were measured objectively. There were no standard instructions for this assessment. However, for the majority of the centres, height and weight were reported by the parents for 6–7-year olds or self-reported for the 13–14-year olds. Body mass index (BMI) was calculated [weight (kg)/height (m)²]. The child or adolescents BMI was categorized as obese and overweight [34] and normal and underweight [35]. Cole et al. [34, 35] used data from six large nationally representative cross-sectional surveys. For each survey, centile curves were drawn that at age 18 years passed through the widely used cut-off points of < 17, 25 and 30 kg/m² for adult underweight, overweight and obesity respectively. The resulting curves were averaged to provide age and sex-specific cut-off points from 2–18 years, and we used the appropriate cut-offs for each subject.

Vigorous physical activity was assessed by the following question: 'How many times a week does your child/do you engage in vigorous physical activity long enough to make him/her breathe hard?' Possible responses were never or occasionally, once or twice a week or three or more times a week.

Television viewing was assessed by the question: 'During a normal week, how many hours a day (24 h) does your child/do you watch television?' possible responses were less than an hour, 1 h but less than 3 h, 3 h but less than 5 h, or 5 h or more.

Statistical analysis

To be included in the analysis, centres had to assess at least 1000 subjects (except Tokelau which was a complete country study) and to have a response rate of $\geq 60\%$ for the children and $\geq 70\%$ for the adolescents. Centres with minor deviations from protocol were included in the analyses and identified by the use of a footnote in the ISAAC publications [36–38]. Odds ratios were calculated with generalized linear mixed models, with a binomial distribution and logit link, and with centres being modelled as a random effect. Analyses were adjusted for sex, region of the world (Africa, Asia Pacific, Eastern Mediterranean, Latin America, North America, Northern and Eastern Europe, Oceania, South-east Asia/Indian Subcontinent, Western Europe), language (Arabic, Chinese, English, Hindi, Indonesian, Portuguese, Spanish and other) and gross national income per capita (categorized by the World Bank as

low, lower middle, upper middle and high). The regression models allowed for the sampling by schools by scaling the size of the sample by the design effect. Interaction between BMI category and sex was assessed by adding the interaction term in the model.

A preliminary analysis compared the results obtained from those with objective measurements of height and weight with those with self- or parental-reported measurements. Although the centres and subjects were different, the magnitude of the association of obese and overweight with an increased risk of current wheeze was similar irrespective of whether the results categories were based on objective or self- or parental-reported measurements (results not shown). We therefore chose to include both sets of measurements, and included an indicator of the measurement type.

No imputation was done for missing data, as previous analyses had shown that little or no bias was introduced by limiting the multivariate analyses to children with complete data [39].

The population-attributable risk of current asthma symptoms for overweight and obesity was calculated with the Mantel–Haenszel approach, with the adjusted relative risk and assuming that 5% were obese and 10% were overweight [40].

Ethics approval

All participating centres obtained local ethics approval.

Results

Study participants

For the 6–7-year age group, data which included the prevalence and the 'risk factor' questions were submitted to the ISAAC International Data Centre (IIDC) from 75 centres in 32 countries (220 407 children). Of these, six centres did not collect height and weight, two centres had inappropriate height data and 38 centres did not provide sufficient BMI data ($\geq 70\%$), and these were excluded. This left 29 centres from 17 countries, which collected BMI data that met the inclusion criteria, of which seven centres (seven countries) reported objective height and weight data and 22 centres (13 countries) supplied the parental-reported height and weight.

For the 13–14-year age group, data which included the prevalence and the 'risk factor' questions were submitted to the IIDC from 122 centres in 53 countries (361 599 adolescents). Of these, 10 centres did not collect height and weight and 39 centres did not provide sufficient BMI data ($\geq 70\%$), and all these centres were excluded. This left 73 centres from 35

countries, which collected BMI data that met the inclusion criteria, of which 17 centres (15 countries) reported objective height and weight data; in 55 centres (28 countries), the adolescents reported their height and weight.

Subjects with missing data for gender, BMI category, vigorous physical activity and television viewing were also excluded, resulting in 76 164 children (21 653 with objective data and 54 511 children with parental-reported data) in the 6–7-year age group and 201 370 adolescents (48 202 with objective data, 150 286 with parental-reported data and 2882 where the method of data collection could not be ascertained) in the 13–14-year age group.

Exposure values for 6–7- and 13–14-year age groups for BMI category, vigorous physical activity and television viewing are shown in Tables S1 and S2 respectively. A world map of overweight and obesity is shown for each age group in Figs 1 and 2.

Association between BMI categories and symptoms of asthma, rhinoconjunctivitis and eczema

Table 1 shows the association between underweight, overweight and obesity and symptoms of asthma, rhinoconjunctivitis and eczema for both age groups. For overweight and obesity, there was a clear association with symptoms of asthma and eczema. Furthermore, there was clear evidence of a dose–effect relationship with the magnitude of the risk of symptoms of asthma and eczema greater with obesity than with

overweight. Underweight was not associated with symptoms of asthma; however, underweight was associated with a decreased risk of symptoms of eczema in the 13–14-year age group. There was no association between BMI category and symptoms of rhinoconjunctivitis.

Association between BMI categories and symptoms of asthma, eczema and rhinoconjunctivitis by sex

Table 2 examined the relationship between underweight, overweight and obesity and symptoms of asthma, rhinoconjunctivitis and eczema by sex for both age groups. There was an increased risk of symptoms of asthma in both sexes in adolescents, but the magnitude of the effect did not differ by gender. However, the increased risk for symptoms of eczema with obesity (but not overweight) was only seen in males for both age groups (*P*-value for interaction: 6–7-year age group *P* = 0.005; 13–14-year age group *P* = 0.011).

Association between vigorous physical activity and symptoms of asthma, rhinoconjunctivitis and eczema

Table 3 shows the association between vigorous physical activity and symptoms of asthma, rhinoconjunctivitis and eczema for both age groups. For the 13–14-year age group, vigorous physical activity (one to two and three or more occasions per week of vigorous physical activity compared with none or occasional) was associated with symptoms of asthma, rhinoconjunctivitis and eczema,

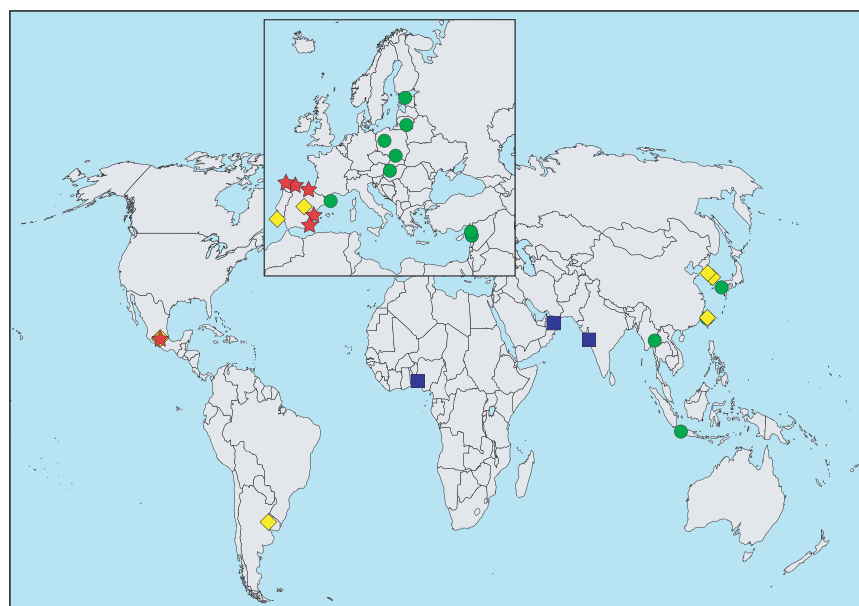


Fig. 1. Prevalence of overweight and obesity (combined) in children 6–7-year-old children in the International Study of Asthma and Allergies in Childhood (ISAAC) centres. The symbols indicate prevalence values of < 10% (blue square), 10 to < 20% (green circle), 20 to < 30% (yellow diamond) and ≥ 30% (red star).

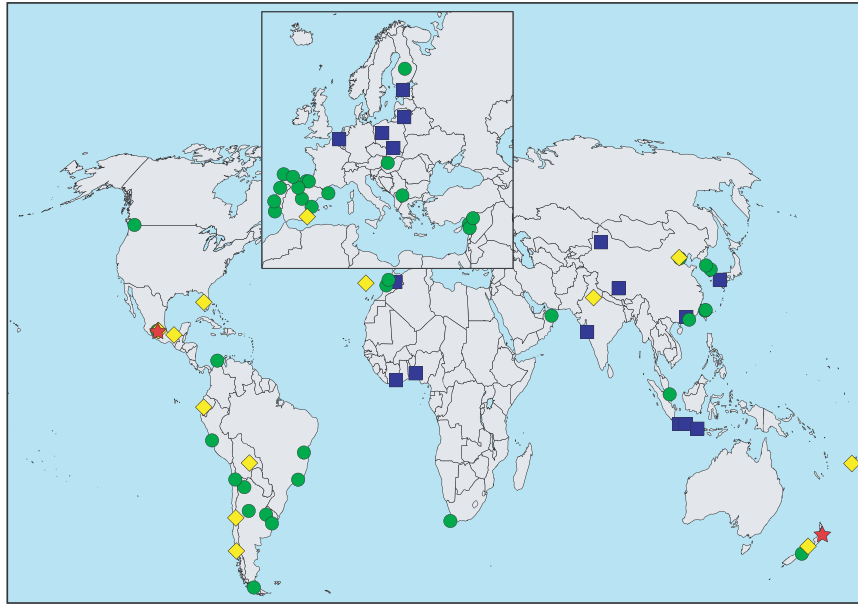


Fig. 2. Prevalence of overweight and obesity (combined) in children 13–14-year-old children in the International Study of Asthma and Allergies in Childhood (ISAAC) centres. The symbols indicate prevalence values of < 10% (blue square), 10 to < 20% (green circle), 20 to < 30% (yellow diamond) and $\geq$ 30% (red star).

Table 1. Association between underweight, overweight and obesity, and symptoms of asthma, rhinoconjunctivitis and eczema at 6–7 and 13–14 years of age. Data are OR (95% CI) and are adjusted for region, language, gross national income, sex, vigorous physical activity, television viewing and BMI measurement type (subjective or objective). The reference category is normal weight. Significant values at the 5% level are in bold

Symptom	6–7-Year age group			13–14-Year age group		
	Underweight	Overweight	Obese	Underweight	Overweight	Obese
Current wheeze	0.96 (0.88,1.06)	1.20 (1.09,1.31)	1.27 (1.12,1.44)	0.94 (0.88,1.01)	1.15 (1.08,1.22)	1.29 (1.14,1.46)
Current wheeze (video)				0.97 (0.88,1.07)	1.16 (1.07,1.26)	1.42 (1.21,1.67)
Current symptoms of severe asthma	1.03 (0.90,1.18)	1.31 (1.15,1.50)	1.47 (1.23,1.75)	1.02 (0.94,1.11)	1.16 (1.07,1.25)	1.39 (1.20,1.61)
Asthma ever	0.91 (0.83,1.00)	1.12 (1.02,1.22)	1.18 (1.05,1.34)	0.96 (0.91,1.02)	1.17 (1.11,1.23)	1.28 (1.16,1.42)
Current symptoms of rhinoconjunctivitis	0.97 (0.88,1.06)	0.99 (0.91,1.09)	0.99 (0.87,1.12)	0.99 (0.93,1.05)	1.03 (0.97,1.09)	0.97 (0.86,1.09)
Current symptoms of severe rhinoconjunctivitis	0.83 (0.64,1.09)	0.96 (0.72,1.27)	1.10 (0.76,1.59)	1.10 (0.93,1.29)	1.10 (0.94,1.30)	1.41 (1.05,1.88)
Current symptoms of rhinoconjunctivitis without wheeze	0.95 (0.86,1.05)	0.92 (0.83,1.03)	1.00 (0.86,1.16)	1.02 (0.96,1.08)	0.98 (0.92,1.04)	0.83 (0.73,0.95)
Current symptoms of eczema	0.92 (0.83,1.01)	1.08 (0.98,1.19)	1.20 (1.05,1.37)	0.89 (0.82,0.97)	1.16 (1.07,1.24)	1.42 (1.23,1.64)
Current symptoms of severe eczema	0.94 (0.74,1.19)	1.03 (0.80,1.32)	0.84 (0.58,1.22)	0.91 (0.77,1.08)	1.13 (0.98,1.31)	1.94 (1.52,2.46)
Current symptoms of eczema without wheeze	0.91 (0.82,1.01)	1.05 (0.95,1.17)	1.19 (1.03,1.37)	0.90 (0.82,0.98)	1.12 (1.03,1.21)	1.34 (1.14,1.57)

however, there was no evidence of a dose–effect relationship. For the 6–7-year age group, only three outcomes reached statistical significance, and this was in the category one to two per week and not three or more

occasions of vigorous physical activity per week. We conclude that any association between vigorous physical activity and symptoms of asthma, rhinoconjunctivitis and eczema in 6–7-year olds is at best marginal.

Table 2. Association between obesity and symptoms of asthma, rhinoconjunctivitis and eczema at 6–7 and 13–14 years of age by sex. Data are OR (95% CI) and are adjusted for region, language, gross national income, sex, vigorous physical activity, television viewing and BMI measurement type (subjective or objective). The reference category is normal weight. Significant values at the 5% level are in bold

Outcome	Gender	Underweight	<i>P</i> Value	Overweight	<i>P</i> Value	Obese	<i>P</i> Value	<i>P</i> Value*
6–7 year age group								
Current wheeze	Female	0.96 (0.84,1.10)	0.915	1.17 (1.03,1.34)	0.734	1.26 (1.03,1.53)	0.951	0.985
	Male	0.97 (0.85,1.10)		1.21 (1.08,1.37)		1.28 (1.09,1.50)		
Current symptoms of severe asthma	Female	1.01 (0.82,1.23)	0.960	1.29 (1.05,1.57)	0.907	1.54 (1.17,2.02)	0.466	0.897
	Male	1.05 (0.88,1.26)		1.32 (1.11,1.58)		1.42 (1.12,1.79)		
Asthma ever	Female	0.89 (0.77,1.03)	0.700	1.08 (0.94,1.24)	0.413	1.18 (0.96,1.44)	0.995	0.803
	Male	0.93 (0.82,1.06)		1.15 (1.02,1.29)		1.18 (1.01,1.38)		
Current symptoms of rhinoconjunctivitis	Female	0.98 (0.86,1.12)	0.680	0.99 (0.86,1.13)	0.976	0.93 (0.76,1.15)	0.758	0.959
	Male	0.97 (0.85,1.09)		0.99 (0.88,1.12)		1.02 (0.86,1.20)		
Current symptoms of rhinoconjunctivitis without wheeze	Female	0.93 (0.80,1.08)	0.895	0.84 (0.71,0.98)	0.118	0.92 (0.73,1.17)	0.601	0.458
	Male	0.97 (0.84,1.11)		0.99 (0.86,1.14)		1.05 (0.87,1.26)		
Current symptoms of eczema	Female	0.91 (0.79,1.04)	0.839	1.07 (0.94,1.22)	0.901	0.97 (0.79,1.19)	0.005	0.044
	Male	0.93 (0.81,1.07)		1.08 (0.94,1.24)		1.39 (1.17,1.64)		
Current symptoms of eczema without wheeze	Female	0.89 (0.77,1.03)	0.681	1.03 (0.89,1.20)	0.688	1.01 (0.80,1.26)	0.030	0.193
	Male	0.93 (0.79,1.09)		1.07 (0.92,1.24)		1.34 (1.11,1.61)		
13–14 year age group								
Current wheeze	Female	0.93 (0.84,1.02)	0.213	1.15 (1.05,1.26)	0.983	1.16 (0.94,1.44)	0.198	0.383
	Male	0.96 (0.86,1.07)		1.16 (1.07,1.26)		1.38 (1.18,1.61)		
Current wheeze (video)	Female	0.99 (0.86,1.13)	0.576	1.22 (1.07,1.38)	0.256	1.27 (0.97,1.66)	0.235	0.331
	Male	0.97 (0.83,1.12)		1.13 (1.00,1.26)		1.51 (1.23,1.84)		
Current symptoms of severe asthma	Female	0.96 (0.85,1.07)	0.015	1.15 (1.03,1.29)	0.884	1.35 (1.06,1.71)	0.712	0.111
	Male	1.11 (0.98,1.26)		1.17 (1.06,1.30)		1.43 (1.19,1.72)		
Asthma ever	Female	0.94 (0.86,1.03)	0.529	1.19 (1.09,1.30)	0.339	1.18 (0.98,1.42)	0.411	0.518
	Male	1.00 (0.92,1.09)		1.15 (1.07,1.23)		1.32 (1.17,1.50)		
Current symptoms of rhinoconjunctivitis	Female	0.97 (0.90,1.05)	0.045	1.03 (0.95,1.12)	0.953	0.83 (0.68,1.01)	0.030	0.040
	Male	1.03 (0.93,1.13)		1.04 (0.96,1.13)		1.07 (0.91,1.25)		
Current symptoms of rhinoconjunctivitis without wheeze	Female	1.00 (0.93,1.09)	0.154	0.97 (0.89,1.06)	0.992	0.72 (0.58,0.89)	0.056	0.142
	Male	1.04 (0.95,1.15)		0.98 (0.90,1.07)		0.92 (0.77,1.09)		
Current symptoms of eczema	Female	0.89 (0.81,0.99)	0.304	1.18 (1.07,1.31)	0.563	1.16 (0.92,1.46)	0.011	0.044
	Male	0.89 (0.77,1.02)		1.14 (1.02,1.27)		1.66 (1.38,1.99)		
Current symptoms of eczema without wheeze	Female	0.90 (0.81,1.01)	0.589	1.15 (1.03,1.28)	0.680	1.12 (0.87,1.45)	0.040	0.189
	Male	0.89 (0.77,1.03)		1.10 (0.98,1.24)		1.52 (1.24,1.88)		

*For a gender difference in the overall associations with obesity and overweight.

Association between television viewing and symptoms of asthma, rhinoconjunctivitis and eczema

Table 4 shows the association between television viewing and symptoms of asthma, rhinoconjunctivitis and eczema. For 13–14-year age group, all outcomes (except asthma ever) showed a statistically significant association with five or more hours of television viewing compared with less than 1 hour. In the 6–7-year age group, television viewing was associated with current wheeze and current symptoms of severe asthma, but not with any of the other outcomes.

There was no interaction between BMI category and vigorous physical activity or television viewing and risk of symptoms of asthma, rhinoconjunctivitis and eczema (results not shown).

Population-attributable risk

Population-attributable risk for current wheeze with overweight and obesity assuming a causal relationship was 3.3% in 6–7-year age group and 3.1% in 13–14-year age group, and assuming that the prevalence of obesity is 5% and overweight is 10%. For current symptoms of eczema, the population-attributable risk was 2.9% (6–7-year age group) and 2.2% (13–14-year age group).

Discussion

Main findings

This study has confirmed the findings from previous cross-sectional studies showing that overweight and

Table 3. Association between vigorous physical activity, and symptoms of asthma, rhinoconjunctivitis and eczema at 6–7 and 13–14 years of age. Data are OR (95% CI) and are adjusted for region, language, gross national income, sex, BMI, BMI measurement type (subjective or objective) and daily television viewing. The reference category is vigorous physical activity never or occasionally each week. Significant values at the 5% level are in bold

Symptom	6–7 year age group		13–14 year age group	
	Once or twice per week	Three or more times a week	Once or twice per week	Three or more times a week
Current wheeze	1.04 (0.96,1.12)	0.83 (0.76,0.91)	1.26 (1.18,1.33)	1.27 (1.19,1.36)
Current wheeze (video)			1.31 (1.21,1.42)	1.28 (1.17,1.41)
Current symptoms of severe asthma	1.30 (1.16,1.45)	0.94 (0.82,1.08)	1.40 (1.30,1.50)	1.49 (1.38,1.62)
Asthma ever	0.96 (0.89,1.04)	0.82 (0.75,0.90)	1.14 (1.08,1.20)	1.12 (1.06,1.18)
Current symptoms of rhinoconjunctivitis	1.11 (1.03,1.19)	0.98 (0.89,1.07)	1.21 (1.15,1.28)	1.25 (1.18,1.32)
Current symptoms of rhinoconjunctivitis without wheeze	1.10 (1.01,1.20)	1.08 (0.97,1.19)	1.15 (1.09,1.21)	1.18 (1.11,1.25)
Current symptoms of eczema	1.02 (0.95,1.11)	0.97 (0.88,1.06)	1.18 (1.11,1.26)	1.24 (1.15,1.34)
Current symptoms of eczema without wheeze	0.99 (0.91,1.07)	0.97 (0.87,1.08)	1.10 (1.02,1.18)	1.15 (1.06,1.25)

Table 4. Association between daily television viewing, and symptoms of asthma, rhinoconjunctivitis and eczema at 6–7 and 13–14 years of age. Data are OR (95% CI) and are adjusted for region, language, gross national income, sex, BMI, BMI measurement type (subjective or objective) and vigorous physical activity. The reference category is less than 1 h television viewing a day. Significant values at the 5% level are in bold

Symptom	6–7 year age group			13–14 year age group		
	1 h but less than 3 h	3 h but less than 5 h	5 h or more	1 h but less than 3 h	3 h but less than 5 h	5 h or more
Current wheeze	1.04 (0.96,1.13)	1.12 (1.01,1.25)	1.26 (1.07,1.47)	0.92 (0.85,0.99)	0.99 (0.92,1.07)	1.08 (1.00,1.17)
Current wheeze (video)				0.96 (0.87,1.07)	1.09 (0.98,1.21)	1.28 (1.14,1.44)
Current symptoms of severe asthma	1.04 (0.92,1.18)	1.20 (1.03,1.41)	1.41 (1.14,1.74)	0.85 (0.77,0.93)	0.95 (0.86,1.04)	1.13 (1.03,1.25)
Asthma ever	0.98 (0.91,1.06)	0.99 (0.89,1.10)	0.96 (0.81,1.14)	0.97 (0.91,1.03)	0.96 (0.90,1.03)	1.05 (0.98,1.13)
Current symptoms of rhinoconjunctivitis	0.93 (0.86,1.00)	1.00 (0.90,1.11)	1.02 (0.86,1.20)	0.94 (0.88,1.01)	1.00 (0.94,1.08)	1.17 (1.09,1.26)
Current symptoms of rhinoconjunctivitis without wheeze	0.90 (0.82,0.98)	0.93 (0.83,1.05)	0.94 (0.78,1.14)	0.98 (0.91,1.05)	1.03 (0.96,1.11)	1.20 (1.11,1.30)
Current symptoms of eczema	0.98 (0.91,1.07)	0.99 (0.89,1.10)	1.05 (0.90,1.23)	0.94 (0.86,1.02)	0.99 (0.90,1.08)	1.16 (1.06,1.28)
Current symptoms of eczema without wheeze	0.91 (0.83,0.99)	0.88 (0.78,0.99)	0.97 (0.82,1.15)	0.97 (0.88,1.07)	0.99 (0.89,1.09)	1.16 (1.04,1.29)

obesity is associated with symptoms of asthma. Furthermore, there is a dose–effect relationship, with obesity increasing the risk of asthma symptoms more than overweight. Previous observations were extended by including both children and adolescents, and by including data from many countries that have not been studied previously. We did not find that overweight or obesity was associated with an increased risk of symptoms of asthma in females compared with males, as has been reported previously [8–10]. Several studies have suggested a U-shaped association between BMI and asthma [12–14], but this was not seen in this study. We speculate that this may be due to publication bias.

Overweight and obesity was not associated with symptoms of rhinoconjunctivitis, but was associated with symptoms of eczema. One recent study has reported an association of overweight with persistent eczema at 5 years of age [41]. We have extended this observation by showing that this association was present in both age groups, and the association was stronger in those that were obese compared with those that were overweight. Furthermore, in both age groups, the increased risk of symptoms of eczema was only in males. This has not been reported previously. In addition, children and adolescents that were underweight were at lower risk of symptoms of eczema, thus

strengthening the dose relationship between BMI and symptoms of eczema.

The epidemiological literature examining the association between obesity and symptoms of asthma is conflicting, although the majority indicate that the risk is higher in females than males. Although the risk of symptoms of asthma with obesity was increased in both boys and girls, we found that the risk was greater in adolescent males than females. Furthermore, there was an increased risk in males of symptoms of eczema with obesity in both age groups.

This study found an increased risk of symptoms of asthma, rhinoconjunctivitis and eczema with exercise in the adolescents. For the younger age group, the findings were not consistent, and are probably best interpreted as showing no association between vigorous physical activity and these outcomes. Some of the inconsistent findings in the literature about asthma and exercise may come about because of the variety of definitions of exercise. The question on exercise used in this study asked about vigorous physical activity enough to make the child or adolescent breathe hard. Exercise in young children is intermittent, with many stops and starts, thus it is probably not surprising that vigorous physical activity was not associated with symptoms of asthma, rhinoconjunctivitis and eczema. The finding that vigorous physical activity was positively associated with symptoms of asthma, rhinoconjunctivitis and eczema in adolescents was unexpected. We had hypothesized that vigorous physical activity would be associated with a reduced risk of asthma symptoms due to reverse causality, that is, those with asthma would exercise less due to exercise-induced wheeze. However, not only was the effect in the opposite direction, but was also seen with symptoms of rhinoconjunctivitis and eczema. There was no evidence of a dose–effect relationship as the magnitude of the associations were similar for 1–2/week and 3 or more/week compared with never or occasionally each week. These unexpected findings are unexplained, although it is possible that children with asthma may be more likely to be breathless with moderate exercise and as a result, are more likely to answer positively to the question about frequency of ‘vigorous exercise long enough to make them breathe hard.’ Alternatively, reverse causality might explain this as asthmatics have been encouraged to exercise. The association between vigorous physical activity and eczema has not been shown previously in epidemiological studies, but if true, is most likely to be explained by sweat-induced itch. Experimental and epidemiological studies have both shown that sweat aggravates itching in individuals with atopic eczema, although the mechanism is still unclear [42, 43].

Sedentary behaviour (such as television viewing) is not the converse of vigorous physical activity, and are two different constructs of physical activity, and thus

should both be considered separately as has been done in this study. Television viewing for five or more hours per day was associated with increased risk of symptoms of asthma, rhinoconjunctivitis and eczema compared with less than 1 h per day in adolescents. In the children, there was an increased risk of symptoms of asthma with television viewing, but not for symptoms of rhinoconjunctivitis and eczema. Furthermore, there was evidence of a dose–effect relationship with the risk increasing with the number of hours (1 to < 3 h = 1.05; 3 to < 5 h = 1.14; 5+ h = 1.27). Television viewing is probably a marker for sedentary behaviour and possibly consumption of high-density foods and obesity [44–46].

There is some evidence that the mechanism relating obesity and asthma may not be allergic [47, 48], and be more dependent on a generalized state of inflammation mediated by adipokines such as leptin. Leptin levels are associated to asthma (mainly to non-atopic asthma), but not with rhinoconjunctivitis [49]. In addition, obesity may favour asthma through mechanical pathways related to sedentary behaviours [20]. Furthermore, both asthma and eczema might be related to diet [50], which could facilitate asthma and/or eczema through oxidative stress pathways, different from allergic ones. Some diets, especially those excluding antioxidant food such as fruits and vegetables, are related to increased obesity.

Strengths and limitations

The major strengths of this study were its size and multi-national nature. The younger age group comprised 76 164 children (29 centres from 17 countries) and 201 370 adolescents (73 centres from 35 countries). We mainly used self-reported symptoms rather than doctors' diagnoses to avoid major diagnostic differences related to access to medical care, language and medical practice. In the case of asthma, the use of symptoms rather than objective measures of bronchial hyperresponsiveness (BHR) or variable airflow obstruction leaves open the possibility that the respiratory symptoms may not necessarily be due to asthma. In support of this concept, a number of studies have reported that increasing BMI is associated with the diagnosis of asthma, symptoms of breathlessness and wheeze in adults, and asthma symptoms and inhaler use in children, but is not associated with BHR. As a result, although obesity is associated with asthma symptoms, this does not necessarily mean it is associated with asthma characterized by reversible airflow obstruction and BHR. Similar considerations apply to the interpretation of the association with symptoms of rhinoconjunctivitis and eczema in the absence of objective measures.

Limitations of this study also need to be considered. The outcomes were assessed by questionnaire, which

were completed by the parents for the younger age group and self-completed by the adolescents. This might lead to misclassification, which would reduce the chance of identifying associations, but is unlikely to result in any systematic bias [51]. Selection bias is also unlikely as the response rate from centres included in these analyses was high.

Objective data of atopy such as serum total or allergen-specific IgE or skin-prick test sensitivity to common allergens was not available in individual subjects, and as a result it was not possible to determine whether the observation that obesity was associated with an increased risk of symptoms of asthma and eczema but not rhinoconjunctivitis indicates that obesity does not affect allergic disease *per se*.

The major limitation was the reliance on parental-reported weight and height for the children and self-reported weight and height for adolescents. Some 28% of children and 24% of adolescents had objectively measured height and weight. However, the preliminary analysis did not show major differences in the associations seen, and thus is unlikely to have changed our conclusions. Physical activity including measuring sedentary activity is possible using accelerometers, but was beyond the scope of this study. The use of questionnaires increases the risk of misclassification, but is unlikely to produce systematic bias.

Conclusions

This study has confirmed the association between overweight and obesity and symptoms of asthma. It has extended these observations to include significant associations with symptoms of eczema, but not rhinoconjunctivitis. Vigorous physical activity was positively associated with symptoms of asthma, rhinoconjunctivitis and eczema in adolescents, but not children. Viewing television for five or more hours was associated with an increased risk of symptoms of asthma, rhinoconjunctivitis and eczema in adolescents and symptoms of asthma in children. Further studies, preferably cohort studies, are required to disentangle the complex relationships between obesity, vigorous physical activity and sedentary behaviour and asthma, rhinoconjunctivitis and eczema.

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Conflict of interest

All authors declare no conflict of interest.

Appendix 1

The ISAAC Phase Three Study Group are given below: *ISAAC Steering Committee*: N Ait-Khaled* (International Union Against Tuberculosis and Lung Diseases, Paris, France); HR Anderson (Division of Community Health Sciences, St Georges, University of London, London, UK); MI Asher (Department of Paediatrics: Child and Youth Health, Faculty of Medical and Health Sciences, The University of Auckland, New Zealand); R Beasley* (Medical Research Institute of New Zealand, Wellington, New Zealand); B Björkstén* (Institute of Environmental Medicine, Karolinska Institutet, Stockholm, Sweden); B Brunekreef (Institute of Risk Assessment Science, Universiteit Utrecht, Netherlands); J Crane (Wellington Asthma Research Group, Wellington School of Medicine, New Zealand); P Ellwood (Department of Paediatrics: Child and Youth Health, Faculty of Medical and Health Sciences, The University of Auckland, New Zealand); C Flohr (Department of Paediatric Allergy and Dermatology, St Johns Institute of dermatology, St Thomas' Hospital, London, UK); S Foliaki* (Centre for Public Health Research, Massey University, Wellington, New Zealand); F Forastiere (Department of Epidemiology, Local Health authority Rome, Italy); L García-Marcos (Respiratory Medicine and Allergy Units, 'Virgen de la Arrixaca' University Children's Hospital, University of Murcia, Spain); U Keil* (Institut für Epidemiologie und Sozialmedizin, Universität Münster, Germany); CKW Lai* (Department of Medicine and Therapeutics, The Chinese University of Hong Kong, SAR China); J Mallol* (Department of Paediatric Respiratory Medicine, University of Santiago de Chile, Chile); EA Mitchell (Department of Paediatrics: Child and Youth Health, Faculty of Medical and Health Sciences,

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Table S1. Exposure prevalence values by centre, 6–7 year age group

Table S2. Exposure prevalence values by centre, 13–14 year age group

Web Table 1: Exposure prevalence values by centre, 6-7 year age group

[illegible]

Centre	BMI Category					Vigorous Physical Activity					Television Viewing					
	Data Avail-able (%)	N	Normal (%)	Over-weight (%)	Obese (%)	Data Avail-able (%)	N	Never or Occas-ionally (%)	Once or Twice Per Week (%)	Three or More Times a Week (%)	Data Avail-able (%)	N	Less Than 1 Hour (%)	1 Hour But Less Than 3 Hours (%)	3 Hours But Less Than 5 Hours (%)	5 Hours or More (%)
Paysandú	98.8	1494	71.2	18.0	10.8	99.6	1506	43.5	31.2	25.3	99.4	1503	20.0	54.8	20.2	5.1
Region total	93.0	10644	73.3	17.0	9.7	98.5	11276	29.8	50.1	20.1	98.3	11247	11.6	58.5	24.8	5.0
Northern & Eastern Europe																
Estonia																
Tallinn	83.6	1993	84.4	13.2	2.4	98.2	2341	29.1	43.7	27.1	98.9	2359	9.2	58.2	24.4	8.1
Hungary																
Svábhegy	99.1	2428	80.5	14.3	5.2	99.7	2444	70.9	18.5	10.6	100.0	2450	17.4	63.2	14.4	4.9
Lithuania																
Kaunas	74.4	2061	86.5	11.3	2.3	92.0	2551	92.9	5.3	1.8	98.1	2718	18.7	63.8	15.2	2.2
Poland																
Kraków	89.7	2240	84.2	12.6	3.2	98.2	2453	32.4	44.0	23.6	99.2	2478	18.4	68.5	10.5	2.6
Poznan	87.1	1742	80.3	15.1	4.6	98.0	1959	31.0	43.5	25.5	99.1	1981	11.4	73.3	12.4	3.0
Region total	86.5	10464	83.2	13.3	3.6	97.1	11748	52.7	30.2	17.2	99.0	11986	15.3	65.1	15.4	4.1
Western Europe																
Portugal																
Portimao	96.1	1027	75.9	14.7	9.4	86.6	926	39.6	49.2	11.1	97.8	1046	12.5	58.0	23.1	6.3
Spain																
A Coruña	78.9	2381	67.7	24.3	8.0	97.1	2929	20.0	36.1	43.9	99.3	2994	24.4	61.6	11.7	2.3
Asturias	89.5	2859	69.9	21.7	8.4	98.0	3128	18.1	32.2	49.7	99.1	3163	27.2	59.3	10.6	2.8
Barcelona	93.1	2794	84.6	11.7	3.7	98.7	2964	8.2	52.2	39.6	99.4	2985	18.6	59.1	19.0	3.3
Bilbao	89.6	2830	69.8	22.4	7.8	97.4	3076	18.7	39.6	41.7	98.9	3122	34.0	53.7	9.8	2.4
Cartagena	76.9	2266	61.6	22.4	16.0	96.4	2841	21.1	40.4	38.5	99.0	2919	15.0	62.5	18.8	3.8
Madrid	80.7	1895	70.1	18.9	10.9	96.9	2275	19.0	37.9	43.0	98.7	2316	17.9	61.3	17.7	3.1
Valencia	70.6	2399	68.2	21.8	10.0	97.0	3295	15.4	37.6	47.0	99.2	3370	22.0	61.0	14.1	2.9
Region total	83.4	18451	71.0	20.0	9.0	96.9	21434	18.1	39.8	42.1	99.0	21915	22.5	59.6	14.8	3.1

Web Table 2: Exposure prevalence values by centre, 13-14 year age group

[illegible]

Centre	BMI Category					Vigorous Physical Activity					Television Viewing					
	Data Available (%)	N	Normal (%)	Over-weight (%)	Obese (%)	Data Available (%)	N	Never or Occasionally (%)	Once or Twice Per Week (%)	Three or More Times a Week (%)	Data Available (%)	N	Less Than 1 Hour (%)	1 Hour But Less Than 3 Hours (%)	3 Hours But Less Than 5 Hours (%)	5 Hours or More (%)
Provincial Korea	94.7	6982	87.0	11.2	1.8	99.1	7312	43.5	47.6	8.9	99.3	7326	16.9	43.8	25.8	13.5
Seoul	94.3	2724	85.2	12.7	2.0	99.2	2866	36.7	51.7	11.6	99.7	2879	14.6	43.0	28.6	13.8
Taiwan																
Taipei	95.5	6091	81.7	14.4	3.9	98.7	6292	18.9	55.5	25.6	98.9	6305	20.4	50.5	20.1	8.9
Taoyuan	94.2	3005	83.1	12.0	5.0	98.2	3131	20.9	54.6	24.5	98.7	3149	15.8	53.5	21.5	9.2
Region total	94.9	52239	87.6	9.7	2.7	98.9	54435	29.8	51.7	18.5	99.1	54567	23.0	46.1	21.1	9.9
Eastern Mediterranean																
Sultanate of Oman																
Al-Khod	98.2	3679	83.2	12.1	4.7	98.6	3694	45.4	36.7	18.0	97.9	3669	26.6	36.6	18.4	18.4
Syrian Arab Republic																
Aleppo	75.5	2314	83.8	14.3	1.9	87.3	2675	31.6	33.5	34.9	96.4	2954	7.8	32.0	35.7	24.6
Lattakia	100.0	3009	86.2	11.9	1.9	96.7	2912	65.4	27.5	7.1	99.4	2993	8.0	39.3	28.3	24.5
Tartous	98.4	2947	84.7	12.1	3.2	97.1	2908	61.4	27.3	11.3	99.6	2982	10.5	41.2	30.0	18.3
Region total	93.2	11949	84.5	12.5	3.1	95.1	12189	50.9	31.5	17.5	98.3	12598	13.9	37.2	27.5	21.3
Indian Sub-Continent																
India																
Mumbai (29)	98.7	1805	98.9	0.9	0.2	99.8	1826	80.3	11.1	8.6	99.6	1822	30.9	56.0	11.1	2.0
New Delhi (7)	100.0	3469	74.9	18.7	6.4	99.1	3437	47.5	34.3	18.2	99.2	3442	21.1	56.6	16.2	6.1
Region total	99.5	5274	83.1	12.6	4.2	99.3	5263	58.9	26.3	14.9	99.4	5264	24.5	56.4	14.4	4.7
Latin America																
Argentina																
Córdoba	88.8	3058	89.4	9.2	1.4	98.7	3399	48.1	36.0	15.9	99.0	3410	6.7	38.5	32.8	21.9
Salta	83.3	2498	85.5	12.5	2.0	99.1	2972	35.5	44.3	20.2	99.5	2984	7.9	36.7	32.5	23.0
Bolivia																
Santa Cruz	87.5	2850	77.6	17.9	4.5	99.1	3227	16.8	52.2	31.1	99.0	3225	12.1	34.8	29.3	23.8
Brazil																
Nova Iguaçu	96.5	3074	84.8	12.0	3.2	98.8	3146	16.0	40.7	43.3	98.3	3130	11.4	26.4	26.5	35.8
Vitória da Conquista	73.0	1225	87.4	9.2	3.3	97.9	1643	42.3	37.9	19.8	98.7	1657	11.1	31.1	26.7	31.0
Chile																
Calama	81.1	1313	83.6	13.7	2.7	98.4	1592	24.7	47.5	27.8	98.5	1593	8.2	27.8	32.5	31.5
Chiloe	99.2	2976	74.3	22.2	3.5	98.0	2940	18.3	53.1	28.6	97.9	2938	7.1	26.8	33.5	32.6

Centre	BMI Category					Vigorous Physical Activity					Television Viewing					
	Data Available (%)	N	Normal (%)	Over-weight (%)	Obese (%)	Data Available (%)	N	Never or Occasionally (%)	Once or Twice Per Week (%)	Three or More Times a Week (%)	Data Available (%)	N	Less Than 1 Hour (%)	1 Hour But Less Than 3 Hours (%)	3 Hours But Less Than 5 Hours (%)	5 Hours or More (%)
Punta Arenas	73.8	2246	80.1	17.5	2.4	99.0	3013	21.3	49.0	29.6	98.3	2993	8.0	33.1	33.1	25.8
South Santiago	89.7	2715	78.8	18.4	2.8	99.1	3000	10.7	42.5	46.8	98.9	2993	6.9	23.5	31.2	38.4
Colombia																
Barranquilla	78.9	2528	86.9	10.3	2.8	99.0	3173	17.4	56.1	26.5	99.1	3175	5.4	23.6	35.3	35.7
Ecuador																
Guayaquil	99.9	3079	75.6	19.6	4.8	99.7	3073	24.5	53.0	22.5	100.0	3081	6.0	26.0	33.2	34.8
Mexico																
Ciudad de México (1)	99.5	3873	70.0	25.7	4.3	93.2	3627	15.5	53.2	31.3	100.0	3890	11.4	57.8	20.5	10.3
Ciudad de México (3)	100.0	3474	73.9	22.5	3.5	100.0	3473	11.3	55.3	33.4	100.0	3473	15.9	44.3	26.2	13.5
Ciudad de México (4)	98.4	2620	72.0	23.4	4.6	96.5	2569	11.0	53.9	35.1	99.7	2654	13.3	41.5	31.3	13.9
Toluca	99.9	3017	82.1	15.5	2.5	98.5	2975	20.0	50.0	30.1	99.3	2999	12.1	38.4	29.7	19.9
Villahermosa	80.6	2505	72.6	21.8	5.5	96.8	3011	24.7	46.5	28.8	97.4	3029	9.9	34.9	32.8	22.4
Peru																
Lima	88.6	2676	83.7	15.1	1.2	97.0	2930	59.2	32.7	8.2	99.2	2998	6.0	35.0	38.2	20.7
Uruguay																
Montevideo	93.0	2954	82.8	15.2	2.0	99.7	3166	11.8	53.7	34.5	99.6	3165	5.5	35.9	36.1	22.5
Paysandú	99.7	1732	85.3	12.5	2.2	99.7	1732	12.9	52.1	35.0	99.8	1735	10.8	39.4	29.6	20.2
Region total	90.6	50413	79.7	17.2	3.2	98.3	54661	22.9	48.1	29.0	99.1	55122	9.2	35.0	31.0	24.7
North America																
Canada																
Vancouver	88.7	2530	82.2	13.5	4.3	98.6	2813	11.5	39.1	49.3	99.3	2832	11.5	41.5	31.6	15.4
USA																
Sarasota	75.8	944	78.9	16.1	5.0	98.3	1224	21.2	36.5	42.2	98.2	1223	9.2	33.8	33.5	23.5
Region total	84.8	3474	81.3	14.2	4.5	98.5	4037	14.5	38.3	47.2	99.0	4055	10.8	39.2	32.2	17.9
Northern & Eastern Europe																
Estonia																
Tallinn	93.3	3363	91.7	7.2	1.1	99.2	3573	20.8	43.8	35.4	99.3	3578	3.8	28.0	40.2	28.0
Finland																
Kuopio County	94.1	2871	85.0	12.6	2.4	99.8	3045	11.8	54.1	34.1	99.7	3041	4.9	38.7	37.2	19.2
Former Yugoslav Republic of Macedonia (FYROM)																
Skopje	96.8	2928	83.9	14.3	1.7	98.4	2978	76.7	15.3	8.0	100.0	3025	3.0	33.7	40.6	22.7

Centre	BMI Category					Vigorous Physical Activity					Television Viewing					
	Data Avail-able (%)	N	Normal (%)	Over-weight (%)	Obese (%)	Data Avail-able (%)	N	Never or Occas-ionally (%)	Once or Twice Per Week (%)	Three or More Times a Week (%)	Data Avail-able (%)	N	Less Than 1 Hour (%)	1 Hour But Less Than 3 Hours (%)	3 Hours But Less Than 5 Hours (%)	5 Hours or More (%)
Hungary																
Svábhegy	99.2	4187	86.6	11.1	2.2	99.9	4213	29.6	36.3	34.1	100.0	4219	6.7	48.0	31.6	13.7
Lithuania																
Kaunas	95.4	2597	93.7	5.5	0.8	97.8	2664	81.5	13.4	5.1	98.2	2674	12.4	50.9	25.8	10.9
Poland																
Kraków	85.7	2181	92.9	6.4	0.6	98.7	2512	7.6	43.2	49.3	98.7	2512	8.6	45.6	29.1	16.7
Poznan	92.7	1739	91.1	7.8	1.1	98.9	1854	10.8	37.3	51.9	99.4	1864	7.5	53.7	26.8	12.0
Region total	94.4	19866	88.9	9.6	1.5	99.0	20839	34.5	35.2	30.3	99.4	20913	6.4	41.7	33.7	18.1
Oceania																
Fiji																
Suva	100.0	3093	79.6	16.8	3.6	99.4	3075	22.7	51.7	25.6	99.9	3090	8.1	24.2	35.4	32.2
New Zealand																
Bay of Plenty	83.7	1654	60.8	27.7	11.5	97.6	1929	14.6	36.1	49.3	97.8	1932	9.0	31.3	33.5	26.2
Christchurch	80.5	2507	81.3	15.2	3.4	98.2	3060	12.7	42.2	45.2	98.4	3065	9.3	39.7	33.2	17.8
Nelson	83.0	1914	79.1	17.8	3.1	99.1	2284	8.7	40.6	50.7	98.6	2272	13.1	40.3	30.8	15.8
Region total	87.4	9168	76.6	18.6	4.9	98.6	10348	15.1	43.5	41.3	98.8	10359	9.7	33.7	33.4	23.2
Western Europe																
Belgium																
Antwerp	87.7	2849	92.7	6.6	0.7	99.3	3228	26.5	45.6	27.9	99.5	3233	9.0	39.4	31.2	20.4
Portugal																
Funchal	77.3	2444	78.4	17.7	3.9	96.3	3043	24.7	52.6	22.7	98.4	3112	11.0	37.4	29.6	22.0
Lisbon	80.4	2431	80.8	16.1	3.0	96.6	2922	18.5	54.9	26.6	98.7	2986	5.0	36.0	35.8	23.1
Portimao	98.2	1089	83.5	13.8	2.8	95.9	1063	23.6	50.2	26.2	98.6	1094	7.2	35.6	34.1	23.1
Porto	85.6	2855	83.4	15.0	1.6	97.4	3249	16.3	53.9	29.8	98.5	3285	8.0	44.6	29.5	17.9
Spain																
A Coruña	86.5	2578	85.6	12.8	1.6	99.0	2949	11.8	50.1	38.1	99.1	2952	11.8	51.6	25.6	11.0
Asturias	96.7	4044	82.5	15.4	2.1	99.2	4152	15.8	44.9	39.3	99.2	4150	12.7	50.0	26.5	10.7
Barcelona	95.5	2928	83.0	16.3	0.8	99.8	3059	10.1	44.5	45.4	99.9	3062	9.4	44.0	31.0	15.6
Bilbao	86.8	2952	87.2	11.8	1.1	99.4	3381	15.6	47.7	36.7	99.2	3375	12.1	46.8	27.2	13.9
Cartagena	93.7	3745	78.9	17.8	3.2	99.2	3966	13.9	50.1	36.0	99.2	3966	8.0	40.9	34.4	16.8
Madrid	85.0	2255	85.5	12.5	2.0	98.4	2610	16.9	48.3	34.8	98.6	2615	9.1	45.2	31.8	13.9

Centre	BMI Category					Vigorous Physical Activity					Television Viewing					
	Data Available (%)	N	Normal (%)	Over-weight (%)	Obese (%)	Data Available (%)	N	Never or Occasionally (%)	Once or Twice Per Week (%)	Three or More Times a Week (%)	Data Available (%)	N	Less Than 1 Hour (%)	1 Hour But Less Than 3 Hours (%)	3 Hours But Less Than 5 Hours (%)	5 Hours or More (%)
San Sebastián	95.1	1136	85.6	13.8	0.6	99.1	1184	16.3	43.4	40.3	99.2	1185	13.6	50.2	24.9	11.3
Valencia	91.0	2849	86.0	12.8	1.2	98.2	3076	14.6	48.8	36.6	99.1	3104	8.6	46.6	30.3	14.5
Valladolid	94.6	2786	85.5	12.9	1.6	99.1	2917	9.6	50.3	40.2	99.3	2922	8.1	46.2	30.8	14.9
Region total	89.2	36941	84.0	14.1	1.9	98.5	40799	16.4	49.0	34.6	99.1	41041	9.5	44.1	30.2	16.2