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The prevalence of underweight in 9–10-year-old schoolchildren in Liverpool: 1998–2006

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Abstract

Objective: To estimate the prevalence of underweight between 1998 and 2006 in Liverpool schoolchildren aged 9–10 years using recently published underweight cut-off points.

Design and setting: Stature and body mass data collected at the Liverpool *Sports*Linx project's fitness testing sessions were used to calculate BMI.

Subjects: Data were available on 26 782 (*n* 13 637 boys, 13 145 girls) participants.

Results: Overall underweight declined in boys from 10·3% in 1998–1999 to 6·9% in 2005–2006, and all sub-classifications of underweight declined, in particular grade 3 underweight, with the most recent prevalence being 0·1%. In girls, the prevalence of underweight declined from 10·8% in 1998–1999 to 7·5% in 2005–2006. The prevalence of all grades of underweight was higher in girls than in boys. Underweight showed a fluctuating pattern across all grades over time for boys and girls, and overall prevalence in 2005–2006 represents over 200 children across the city.

Conclusions: Underweight may have reduced slightly from baseline, but remains a substantial problem in Liverpool, with the prevalence of overall underweight being relatively similar to the prevalence of obesity. The present study highlights the requirement for policy makers and funders to consider both ends of the body mass spectrum when fixing priorities in child health.

Keywords
Body mass index
Childhood underweight
Body composition
*Sports*Linx

Underweight contributes substantially to the global disease burden, and is associated with mortality[1]. The majority of deaths caused by underweight are attributed to moderate levels of underweight, with evidence indicating a spectrum of risk associated with underweight, with no apparent threshold effect[1,2]. In addition, many health policy makers have attempted to combat the problem by viewing underweight as an additive health problem, rather than viewing the relationship between underweight and morbidity as synergistic, i.e. underweight has a potentiating rather than additive effect on mortality[2]. Underweight in preschool years has also been linked with impaired cognitive function[3], fewer years of completed schooling, poor growth and potential for reduced lifetime earnings[4].

The majority of empirical research conducted on childhood underweight is carried out in developing countries, and on children <5 years of age. One study conducted in the UK, using the UK 1990 growth chart definition[5] of underweight, described a prevalence of 3·3% in preschool children, where underweight was 'significantly more common than expected' and was related to social deprivation[3]. Armstrong *et al.*[3] suggested that if underweight persisted through childhood, this may have implications for cognitive development, school achievement and long-term health. Authors called for further study into underweight in children in developed nations to assess the persistence of underweight, and the long-term developmental risks of underweight[3]. One study assessing trends in obesity and underweight in children aged 6–18 years described prevalence of underweight at 3·3% in the USA using a representative survey from 1988 to 1994[6], using the WHO definition of underweight in children[7]. Similar evidence detailing the prevalence of underweight in developed nations is particularly scarce, especially in children >5 years of age, and no such evidence for older children in UK could be sourced to date, representing a significant gap in the current literature.

Paediatric underweight has taken rather a 'back seat' in recent years to the 'obesity epidemic', perhaps understandably due to the huge health and economic implications of childhood obesity. Underweight remains a serious public health issue, and although seemingly

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smaller numbers of individuals are affected in comparison to paediatric obesity, children with modest levels of underweight may be at an increased risk of health problems, including all-cause mortality, as well as skeletal disorders in later life[8]. There is a requirement therefore to assess the prevalence of underweight in developed nations as a body mass disorder that has received very little attention in recent years, but has implications for service provision and health promotion.

A revised classification system for underweight has been developed for use with BMI data, allowing accurate classification of children aged 2–18 years[9]. This classification system uses age- and sex-specific cut-off points to classify children as either grade 1, 2 or 3 underweight and uses the same data set and methods of calculation as the international obesity age- and sex-specific cut-off points[10]. BMI values at age 18 years for grade 1 ($\leq$18·5 kg/m^2), 2 ($\leq$17 kg/m^2) or 3 ($\leq$16 kg/m^2) underweight were extrapolated back through childhood, taking normal growth and development into account using the LMS method. Grade 2 underweight represents a BMI of $\leq$17 kg/m^2 at age 18 years, and also corresponds to the WHO definition of underweight in children at -2SD. Grade 1 underweight corresponds to the adult underweight cut-off point, with grade 3 underweight representing the most extreme underweight cut-off point[9]. Using these cut-off points, it is now possible to estimate the scale of the underweight problem using easily collected data.

In Liverpool the *Sports*Linx project[11] provides unique data on schoolchildren across the city, and annually assesses motor performance, body composition and dietary behaviour in approximately 4000 Liverpool 9–10-year-olds. The aim of the present study was to use the *Sports*Linx data archive to estimate the prevalence of underweight over time using the recently published international cut-off points for underweight[9] as a scoping exercise and reference point for future studies assessing underweight in older children.

Methods

The *Sports*Linx project is a collaborative project conducted by Liverpool City Council in partnership with Liverpool John Moores University and Liverpool PCT. *Sports*Linx has annually assessed aspects of motor fitness, body composition, dietary habits and health behaviours in 9–10-year-old schoolchildren since its inception in 1998. *Sports*Linx has institutional ethical approval and all primary schools in the Liverpool Local Education Authority (LEA) were invited to take part in *Sports*Linx annually. Parental consent, participant assent and medical screening forms were collected prior to participant involvement in testing procedures.

Stature and body mass to the nearest 0·01 m and 0·1 kg (Seca, Bodycare, Birmingham, UK), respectively, were recorded by trained fitness officers on the *Sports*Linx field-based motor fitness sessions called 'Fitness Fun Days'[11] from academic years 1998–1999 through to 2005–2006. These data were used to calculate BMI (body mass (kg)/stature^2 (m^2)). These BMI data were then used to estimate the prevalence of underweight from 1998 to 2006 using age- and sex-specific cut-off points[9].

Results

Complete BMI data were available for 26 782 (*n* 13 637 boys, 13 145 girls) 9–10-year-old participants (Year 5). In total, 141 schools were involved in the project from 1998 to 2006, coverage (percentage of all primary schools in Liverpool LEA) was as follows: 1998–1999, 59 %; 1999–2000, 67 %; 2000–2001, 73 %; 2001–2002, 68 %; 2002–2003, 63 %; 2003–2004, 88 %; 2004–2005, 76 %; 2005–2006, 68 %. The most common reasons for schools declining to participate in *Sports*Linx were imminent governmental inspections (e.g. Ofsted) or transportation difficulties.

Tables 1 and 2 show the prevalence of underweight from 1998–1999 to 2005–2006 for boys and girls, Fig. 1 displays the overall prevalence of underweight for boys and girls over the eight-year period.

Boys' results show a decline in total underweight from 10·3 % in 1998–1999 to 6·9 % in 2005–2006; however, this is still a substantial number of boys, as 6·9 % of the participants represents over 100 boys. All sub-classifications of underweight have declined in boys, showing large declines in the most severe form of underweight (grade 3), with the most recent prevalence being 0·1 %. Despite these reductions, the figures show a fluctuating pattern of underweight prevalence for boys, and so further years' data are required to confirm any decline in underweight. Girls' data show a decline in all grades of underweight

Table 1 Prevalence (%) of underweight in Year 5 boys: 1998–2006

Year	Total underweight	Grade 3 underweight	Grade 2 underweight	Grade 1 underweight	Total participants
1998–1999	10·3	0·5	0·8	9·0	1625
1999–2000	9·7	0·1	1·1	8·5	1856
2000–2001	7·7	0·5	0·5	6·7	1946
2001–2002	8·4	0·4	1·2	6·8	1534
2002–2003	6·9	0·3	0·8	5·8	1476
2003–2004	6·8	0·8	0·7	5·3	1971
2004–2005	7·9	0·5	0·9	6·5	1744
2005–2006	6·9	0·1	0·9	5·9	1485

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Table 2 Prevalence (%) of underweight in Year 5 girls: 1998–2006

Year	Total underweight	Grade 3 underweight	Grade 2 underweight	Grade 1 underweight	Total participants
1998–1999	10·8	0·3	1·7	8·8	1550
1999–2000	9·9	0·2	0·9	8·8	1816
2000–2001	7·8	0·3	0·5	7·0	1902
2001–2002	6·8	0·4	1·3	5·1	1359
2002–2003	7·0	0·4	1·0	5·6	1432
2003–2004	6·4	0·9	0·9	4·7	1992
2004–2005	8·0	0·7	1·2	6·1	1652
2005–2006	7·5	0·2	0·9	6·4	1442

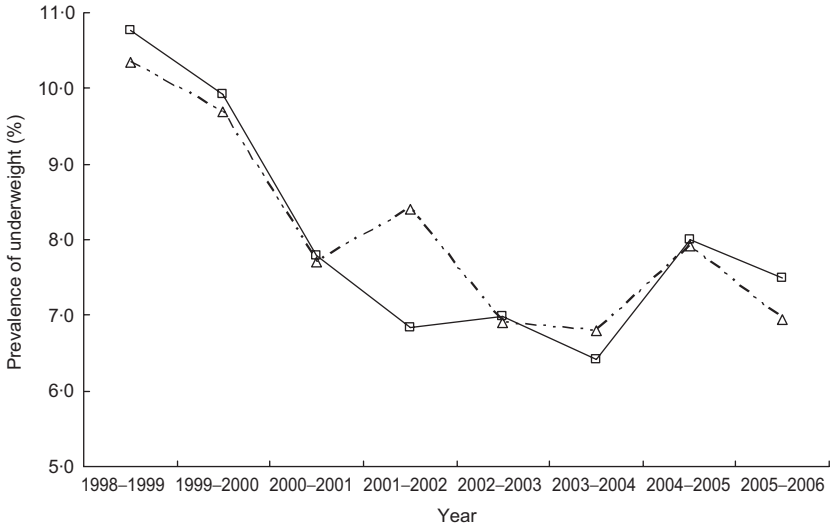

Fig. 1 Prevalence of underweight in 9–10-year-old boys (– · △ – ·) and girls (—□—) (1998–2006)

from baseline, with total underweight reducing from 10·8% in 1998–1999 to 7·5% in 2005–2006. Girls' prevalence remains relatively high at 7·5% (representing over 100 girls), with 1% of girls classed as grade 2 underweight. Underweight was more prevalent in girls than in boys across all grades of underweight. The prevalence of underweight in girls has reduced, but fluctuated similarly to that for boys, with a substantial decline in grade 3 underweight in recent years, which may be due in part to yearly variations in participant numbers and to the small absolute number of participants in this category of underweight.

Despite these apparent declines in the prevalence of underweight, the most recent year's (2005–2006) data do not display the lowest observed prevalences when compared to all study years.

Discussion

There is a suggestion of a fall in the prevalence of underweight, but cohort effects cannot be ruled out. However, the main finding is the relatively high prevalence observed, which deserves more attention. The evidence presented in the present study described a decline in levels of underweight over time. Therefore, fewer children appear to be at risk of underweight-related disorders, including poor bone health and all-cause mortality[1]. These reductions in prevalence may be as a result of the many health promotion initiatives in place across the city, suggesting anti-obesity strategies promoting healthy lifestyles and dietary habits may positively influence children across the BMI spectrum. Despite this finding, it is important to note the fluctuating pattern in underweight observed in boys and girls. When looking at individual years, a reduction in underweight when comparing the most recent cohort's data (2005–2006) was apparent from baseline (1998–1999), but the most recent cohort did not display the lowest prevalence of underweight in comparison to all study years, i.e. other cohorts had lower prevalences of underweight. Therefore, we cannot conclude that underweight has steadily reduced, year-on-year, but that there was an unsteady, fluctuating pattern in prevalence.

The prevalence of underweight in the most recent cohort remained relatively high at 6·9% in boys and 7·5% for girls. This prevalence was substantially higher than that previously reported in preschool children in the

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UK[3], and older children in the USA[6]. The prevalence of underweight represents over 200 children in one school year group in Liverpool who were potentially at risk of underweight-related disorders. The prevalence of obesity in 2005–2006 was 7·6% in boys and 9·2% in girls[12]. In the case of boys, the prevalence of underweight and obesity was quite similar, differing by 0·7%, whereas the difference was slightly higher in girls at 1·3%. Despite the similarity in prevalence, there has been a huge difference in attention and resources apportioned to obesity.

The mechanism behind the development of underweight in the population is relatively unknown in older children and is extremely complex. Evidence from the UK found links between preschool underweight and social deprivation score[3], whereas a US-based study found no difference in the prevalence of underweight in families receiving or not receiving state benefits[13]. One limitation of the study is the lack of control for socio-economic status. Despite this, Liverpool is an area of low socio-economic status, with many wards of the city among the most deprived in the country. Therefore, relatively high levels of underweight may have been expected, but cannot be compared to other regions as published data using the same classification system are not available. Underlying disease may also contribute to the prevalence of underweight[13], which supports the synergistic theory[2] of underweight where a 'chicken and egg' situation may exist; poor health and disease often lead to underweight, but underweight independently increases the risk of contracting disease[14].

Despite the drawbacks, the aim of the study was to estimate the prevalence of underweight across the City from 1998 to 2006 as a starting point to estimate the scale of the problem and provide a reference point, using the new standards, for comparison with other data sets and future trends. The study shows that in at least one large city a problem exists, which may not be fully recognised and is in danger of being overwhelmed by the problem of obesity. The high prevalence of underweight identified highlights the need to consider both ends of the spectrum of body mass, i.e. from underweight to obese. Both extremes are public health concerns and may have serious implications for the health of individuals, and public health policy and service provision. More attention should be diverted towards understanding the implications of underweight in school age children, which are currently relatively unknown.

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