EDITOR'S CHOICE

Weight status and perceived body size in children

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ABSTRACT

Objective: To investigate associations between weight status and body size perception in children in the UK.
Design: Cross-sectional survey.
Setting: School-based sample in the UK.
Participants: 399 children (205 boys, 194 girls) aged 7–9 years.
Main outcome measures: Perceived body size was assessed using a visual method (Children's Body Image Scale, matching to images representing body mass indexes (BMI) from 3rd to 97th percentiles) and verbal descriptors from "too thin" to "too fat". BMI (converted to BMI SD scores using UK data) was assessed and demographic information was recorded.
Results: Modest associations between actual and perceived body size were found with visual ($r = 0.43$, $p<0.001$) and verbal ($r = 0.41$, $p<0.001$) methods, but there was a consistent response bias towards underestimation. Using visual matching, most children (45%) underestimated their body size, with significantly greater underestimation ($p<0.001$) at higher BMI. A gender-by-weight group interaction ($p = 0.001$) showed that at lower weights girls were more accurate than boys, but at higher weights girls were less accurate. Using the verbal scale, the majority of children reported their body size as "just right" in all weight groups (52–73%), with no sex differences.
Conclusions: Children can estimate their body size using visual or verbal methods with some accuracy, but show greater underestimation at higher weights, especially in girls. These findings suggest that underestimation is more widespread than has been assumed, which has implications for health education among school-aged children.

What is already known on this topic

- Adults and adolescents are inaccurate in estimating their body size with more overestimation in women and more underestimation in men.
- Some evidence shows an increasing prevalence of underestimation, with women, as well as men underestimating their body size.

What this study adds

- The first study to assess body size estimation in pre-adolescents.
- Showed a high level of underestimation, particularly in overweight girls.
- Health education initiatives and weight management programmes need to be aware of the underestimation of body size.

Women are well known to overestimate their weight and men to underestimate in many cultures.[1–3] However, a trend towards greater underestimation has emerged in the past two decades, evidenced by survey comparisons from America and the UK. This could be due to changes in the normative status of overweight or effects of obesity publicity.[4 5]

Young people's perception of their weight status attracted much interest during peak concern about eating disorders,[6] but is now being revisited in light of the obesity epidemic. Two studies observed the adult pattern of overestimation in young women and underestimation in young men using verbal scales,[7 8] but a recent study with overweight adolescents showed a third underestimated their weight, with no sex differences.[9] Another study using verbal and visual scales found almost half the boys and one-third of girls underestimated their size.[10]

Recent research with younger children indicates a similar pattern. A Canadian study found that overweight/obese children underestimated more than other weight groups, exacerbated by having overweight classmates and parents.[11] Two studies of overweight/obese children reported conflicting findings: Latino children demonstrated poor body size awareness,[12] whereas an Italian sample showed good accuracy.[13] However, both studies assessed body perception using sketched silhouettes representing increasing weights but not specific body mass indexes (BMI) so judgements of absolute accuracy were not possible.

Body images with known sizes are now available.[14 15] These complement verbal description methods (eg, scales from "very underweight" to "very overweight"),[5 7 15 16] which cannot discriminate between body size being misperceived or only mislabelled. These methods have not yet been used with pre-adolescents.

The present study investigated body size perception in pre-adolescents using verbal descriptor and BMI-calibrated visual-matching methods to examine associations between perceived and actual body size across the weight spectrum in a community-based British sample.

METHODS

Participants

Children were recruited into the Physical Exercise and Appetite in CHildren Study (PEACHES), a longitudinal study of weight gain during childhood in five north London schools (UK) that includes parent and child measures of eating behaviour and physical activity. Families with children in years 3/4 (7–9 years old; n = 531) were invited to

participate. 405 parents (76%) provided informed consent for body image and anthropometric measurements. One child had insufficient English to complete the questions; four were unavailable on the testing day. Complete data were collected from 399 children (205 boys, 194 girls) between September 2006 and February 2007. Ethical approval for the study was granted by the University College London Committee on the Ethics of Non-NHS Human Research.

Measures

Demographics

Date of birth, gender, ethnicity and home postcodes of children were provided by schools. Ethnicity was reported as white, black/mixed black, Asian/mixed Asian or other, but re-coded to white/non-white because of limited sample sizes. Postcodes were used to estimate socioeconomic deprivation of home neighbourhoods according to 1991 census information using the Townsend index.[17] Scores above zero indicate above national average levels of deprivation. Missing postcodes were replaced by the mean value for the child's school.

Anthropometry

Measurements were taken by trained researchers using standard protocols. Height without shoes was recorded to the nearest millimetre using Leicester height measures (Seca, Birmingham, UK). Weight was measured using Tanita TBF300MA, to the nearest tenth of a kilogramme minus 1 kg for clothing.

BMI from height and weight was converted into age and sex-appropriate BMI standard deviation scores (SDS) using British 1990 reference data.[18] Weight categories were created using International Obesity Taskforce criteria for healthy weight, overweight and obesity, recently adapted to include underweight (thinness grade 1, 2 or 3).[19] We created a subdivision of the healthy weight group into lower (<50th centile but not underweight) and higher healthy weight (>50th centile but not overweight) groups to examine responses across the adiposity spectrum.

Children's body image scale

The children's body image scale (CBIS)[14] consists of seven gender-specific figures posed in the anatomical position (figure 1). Each figure is a modified photograph of an anonymised, pre-pubescent boy or girl with a BMI within the specified range for one of seven National Center for Health Statistics (NCHS) percentiles (3rd–97th) for 10 year olds.[20] Figures are horizontally arranged in ascending order of adiposity and labelled 'A' to 'G' (alphabetical labels were converted into numbers '1' to '7', respectively, for analysis). ''Perceived body size'' is assessed by asking the child to identify the figure most similar in size to them. Mean (SD) figures selected by girls and boys aged 7–12 years in the validation sample were 3.10 (1.32) and 2.91 (1.27), respectively.[14] Good test–retest reliability for perceived body size (girls r = 0.85, boys r = 0.76, p<0.001) has been demonstrated.[15]

Because CBIS figures denote gender and age-specific BMI ranges, each child's BMI, unadjusted for age/gender, was used to determine the figure closest to their size (''actual body size''). The accuracy of perceived size was calculated by subtracting the ''actual'' figure number from the ''perceived'' (score range −6 to +6). Negative scores indicate underestimation, zero accurate selection and positive scores overestimation of size.

We also administered a verbal descriptor scale for perceived body size, with one item: ''do you think your body is: much too thin, too thin, just right, too fat, or much too fat'', used in previous studies.[16 21 22] ''Much too fat'' and ''too fat'' categories were combined, as were ''much too thin'' and ''too thin'', because few children selected the extremes.

Procedure

Children were tested individually at school in a private space. The child was guided through the CBIS and asked to identify the figure most similar to their own body size. The verbal scale and response options were then read aloud by the researcher from a laminate visible to the child, who pointed to or verbalised their answer. It was emphasised that there were no right or wrong answers, and that the researchers would not share the child's responses, although the child was free to do so if they wanted. Finally, anthropometric measurements were taken. Children were not given feedback about measurements in accordance with ethical requirements.

Data treatment and statistical analyses

Although the body image measures produce ordinal data, they were treated as interval in line with previous research using the CBIS[14 15] and other widely used verbal and visual body image scales[11 16 23] to enable comparability of findings. We used Pearson's correlations to assess associations between perceived and actual body size for the visual measure, and between BMI SDS and verbal ratings. Data were also analysed separately by sex because boys may be less accurate than girls at this age.[14] Differences between correlations for boys and girls were tested for statistical significance (Z_{obs}).[24] The accuracy of visually perceived body size was plotted by sex-weight groups. We compared proportions of children underestimating or overestimating their size in each weight group (χ^2) and used analyses of covariance (ANCOVA) to investigate weight group differences in perceived body size accuracy. The data did not violate ANCOVA assumptions.

RESULTS

Sample characteristics

Descriptive statistics overall and by sex are presented in table 1. There were similar numbers of boys and girls (51% male). Most children were in lower or higher healthy weight groups (65%), 16% were classified as underweight and 19% as overweight/obese. Compared with UK averages, this sample had fewer overweight/obese and more underweight children.[25] The sample was ethnically mixed (52% non-white) and neighbourhood socioeconomic deprivation was high (4.31).

Table 2 shows the percentage of children whose actual body size matched each figure and those choosing each figure as like them.

Perceived body size: visual matching

Actual and perceived body size were correlated (r = 0.43, p<0.001) indicating that fatter children tended to choose fatter figures and vice versa. Correlations were significantly stronger in girls (r = 0.49, p<0.001) than boys (r = 0.32, p<0.001; $Z_{obs} = -2.02$).

In the whole sample children showed considerable underestimation (table 3). A quarter of children had BMI in the higher range (CBIS figures 5–7, table 2), but only 10% selected those figures as a match. ANCOVA including weight group, ethnicity, gender and Townsend score showed a significant main effect of weight group (F(4,360) = 59.43, p<0.001) and a significant gender-by-weight interaction (F(4,360) = 5.05, p = 0.001) with

Table 1 Anthropometric and demographic sample characteristics: (mean (SD) or percentage)

	Girls (n = 194)	Boys (n = 205)	Total sample (n = 399)
Age, years, months	8.28 (0.62)	8.27 (0.65)	8.28 (0.64)
BMI, kg/m^2	16.57 (2.73)	16.47 (2.54)	16.52 (2.63)
BMI, SD*	0.12 (1.40)	0.12 (1.31)	0.12 (1.35)
BMI, centile	52.68 (34.93)	51.38 (34.40)	52.01 (34.62)
Weight category†			
% Underweight	14.9 (n = 29)	17.1 (n = 35)	16 (n = 64)
% ⩽50th Centile but not underweight	30.4 (n = 59)	31.7 (n = 65)	31.1 (n = 124)
% >50th Centile but not overweight	35.6 (n = 69)	33.2 (n = 68)	34.3 (n = 137)
% Overweight	12.9 (n = 25)	13.7 (n = 28)	13.3 (n = 53)
% Obese	6.2 (n = 12)	4.4 (n = 9)	5.3 (n = 21)
Ethnicity			
% White	42.8 (n = 83)	43.9 (n = 90)	43.4 (n = 173)
% Non-white	52.1 (n = 101)	52.2 (n = 107)	52.1 (n = 208)
% Ethnicity missing	5.2 (n = 10)	3.9 (n = 8)	4.5 (n = 18)
Area deprivation level‡	4.33 (3.46)	4.28 (3.54)	4.31 (3.50)

*SD score based on British 1990 norms.[18] †Based on International Obesity Taskforce Criteria with additional subdivision of lower and higher healthy weight groups.[19] ‡Area deprivation measured using the Townsend index.[17] BMI, body mass index.

no other significant effects. A clear pattern from overestimation to underestimation from lighter to heavier ends of the weight spectrum was confirmed by the linear trend ($p<0.001$).

Mean scores on perceived body size accuracy by sex/weight groups are shown in figure 2 indicating the degree of body size "misperception" (the mean number of figures away from actual body figure) and the direction of error (over or underestimation). It shows that healthy weight girls overestimated or underestimated less than boys, whereas obese girls underestimated more than boys.

Perceived body size: verbal ratings

Verbal ratings (scored 1–5) and BMI SDS were significantly correlated ($r = 0.41$, $p<0.001$). In contrast to the visual method there were no differences between girls ($r = 0.41$) and boys ($r = 0.44$; $Z_{obs} = 0.36$). The majority of children in all weight groups identified their body size as "just right" (table 4) including 58% and 52% of overweight and obese children indicating underestimation of size. Many healthy weight children also reported being "too thin" (20% of lower and 8% of higher healthy weight), again suggesting underestimation of size.

Comparing visual and verbal methods

Correlations between perceived body size and BMI SDS were comparable for visual ($r = 0.41$, $p<0.001$) and verbal ($r = 0.42$, $p<0.001$) ratings. Visual and verbal ratings correlated significantly with one another ($r = 0.35$, $p<0.001$), but the absolute degree of overestimation varied by method. Among overweight/obese children, 57% underestimated using verbal ratings compared with 92% using the visual method.

Table 2 Proportions of children matched to each of the seven CBIS figures according to measured BMI and the children's own perceptions

CBIS figure category number	% of children (n) in each figure category based on measured BMI (actual body size)	% of children (n) who chose each figure as most like theirs (perceived body size)
1	19.0 (76)	12.3 (49)
2	19.3 (77)	24.3 (97)
3	21.3 (85)	35.8 (143)
4	15.8 (63)	18.3 (73)
5	18.0 (72)	7.8 (31)
6	5.5 (22)	1.3 (5)
7	1.0 (4)	0.3 (1)

BMI, body mass index; CBIS, children's body image scale.[14]

DISCUSSION

To our knowledge this is the first study to investigate the accuracy of body size perception in pre-adolescent children across the weight spectrum using a BMI-calibrated visual scale, and is unusual in comparing visual and verbal estimation methods. BMI SDS was modestly correlated with both indicators of perceived size, suggesting general awareness of body size in boys and girls. However, consistent biases were observed, with the verbal method revealing a strong preference for "just right", and the visual that more than one-third of children selected a figure slimmer than their own.

The accuracy of body size perception using visual matching varied with weight status. Lighter children (<50th centile of healthy weight) were more likely to identify a figure larger than their own, but heavier children showed a striking tendency towards underestimation of size, particularly obese girls. Over 90% of overweight/obese children chose a figure substantially smaller than their own. The verbal descriptor method confirmed the underestimation seen with the visual method, with fewer than half of overweight/obese children identifying themselves as "too fat". Using the verbal scale, 58% of overweight children and 52% of obese children selected "just right".

One explanation for the results with the verbal scale is that children were reluctant to admit to "thinness" or "fatness", especially given the phrasing "too thin/fat". This could also be explained by the fewer response options available with the verbal scale (5) compared with the visual (7), although few children chose the extreme figures on the visual scale. Girls may be more reluctant than boys to use these terms of themselves. Both thin and fat images are described more negatively than mid-range figures by children around this age,[26 27] and children may choose not to self-identify with stigmatised body sizes. However, using the visual task, the most frequently chosen figures represented the 25th and 10th centiles, both of which are relatively thin, suggesting a genuine underestimation of size, whether the judgement is absolute or relative. The visual-matching task can be considered a more precise measure of body size perception, which could explain the greater sensitivity to sex differences.

Table 3 Percentage (n) of children underestimating, accurately identifying and overestimating their body size using visual ratings

True weight category*	% (n) Choosing a thinner figure (underestimation)	% (n) Choosing the correct figure (accurate)	% (n) Choosing a fatter figure (overestimation)
Underweight (n = 64)	3.1 (2)	29.7 (19)	67.2 (43)
Boys	0.0 (0)	28.6 (10)	71.4 (25)
Girls	6.9 (2)	31.0 (9)	62.1 (18)
⩽50th Centile but not underweight (n = 124)	22.6 (28)	31.5 (39)	46.0 (57)
Boys	23.1 (15)	24.6 (16)	52.3 (34)
Girls	22.0 (13)	39.0 (23)	39.0 (23)
>50th Centile but not overweight (n = 137)	59.1 (81)	25.5 (35)	15.3 (21)
Boys	72.1 (49)	19.1 (13)	8.8 (6)
Girls	46.4 (32)	31.9 (22)	21.7 (15)
Overweight (n = 53)	90.6 (48)	9.4 (5)	0.0 (0)
Boys	89.3 (25)	10.7 (3)	0.0 (0)
Girls	92.0 (23)	8.0 (2)	0.0 (0)
Obese (n = 21)	95.2 (20)	4.8 (1)	0.0 (0)
Boys	88.9 (8)	11.1 (1)	0.0 (0)
Girls	100 (12)	0.0 (0)	0.0 (0)

*Based on International Obesity Taskforce Criteria with additional subdivision of lower and higher healthy weight groups.[19]

The predominance of underestimation rather than overestimation, especially in girls, is surprising given the widespread assumption that most girls "feel fat", regardless of their true size; a "fact" regularly reiterated by the media. The change towards underestimation observed in this and other recent studies could be due to changes in societal norms, whereby conceptions of "just right" are based on perceptions of the "average", and as the population average is considerably larger than before, higher body weights would become normalised. This has been suggested as a mechanism for inaccurate weight status perception in adults,[4] but it would not explain the widespread choice of relatively thin CBIS figures.

In the context of related research, our results are similar to findings with adolescents and adults indicating widespread underestimation of body size, which is more pronounced in overweight/obese individuals.[1–3 7] The main difference is that adult men seem to be more prone to underestimation than women, whereas in children we found either no sex difference (verbal method) or greater underestimation in heavier girls (visual method). Whether this is an effect of maturation or a cohort effect remains unclear.

These results raise the question of whether underestimation matters. Perhaps young children should feel "just right", and the fewer who feel body dissatisfaction the better. But there must also be concern about longer-term consequences if children cannot perceive themselves accurately. One reason for low public awareness of overweight may be that perceptions are clouded by extreme media images of obesity, which perpetuate dissociation between the "just right" self and obese "others".

Body size misperception could influence the perceived relevance of health recommendations and the efficacy of weight management interventions.[11] In children of this age, parents are the main gatekeepers of lifestyle change, and they also underestimate their children's weights.[28] Children's own perceptions ought to be considered if weight management practices are to be taken forward into later childhood. Whereas young children do not consider their weight and associated management in the same way as older children or adults, the inclusion of sensitive weight feedback has been shown to be beneficial to weight management in a similar age group[29] and could be adapted for specialist health education. Understanding of the magnitude of body size misperception using the CBIS could be a useful

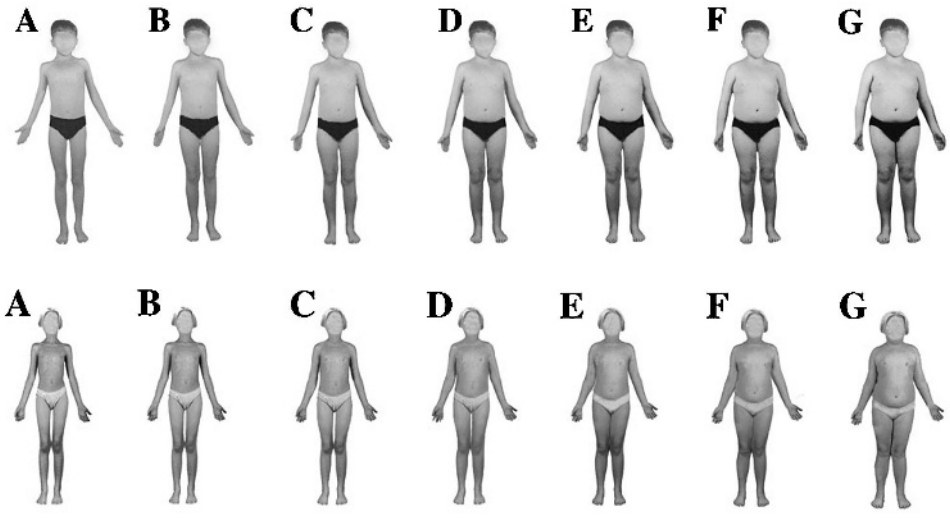

Figure 1 Mean inaccuracy (standard error) of body size perception using visual ratings.

Table 4 Percentage (n) of children identifying their body size as too thin, just right or too fat using verbal ratings

Weight category*	% (n) Reporting body is "too thin" or "much too thin"	% (n) Reporting body is "just right"	% (n) Reporting body is "too fat" or "much too fat"
Underweight (n = 64)	34.4 (22)	60.9 (39)	4.7 (3)
Boys	34.3 (12)	62.9 (22)	2.9 (1)
Girls	34.5 (10)	58.6 (17)	6.9 (2)
⩽50th Centile but not underweight (n = 124)	16.9 (21)	72.6 (90)	10.5 (13)
Boys	23.1 (15)	64.6 (42)	12.3 (8)
Girls	10.2 (6)	81.4 (48)	8.5 (5)
>50th Centile but not overweight (n = 137)	8.0 (11)	70.8 (97)	21.2 (29)
Boys	4.4 (3)	75.0 (51)	20.6 (14)
Girls	11.6 (8)	66.7 (46)	21.7 (15)
Overweight (n = 53)	0.0 (0)	58.5 (31)	41.5 (22)
Boys	0.0 (0)	53.6 (15)	46.4 (13)
Girls	0.0 (0)	64.0 (16)	36.0 (9)
Obese (n = 21)	0.0 (0)	52.4 (11)	47.6 (10)
Boys	0.0 (0)	55.6 (5)	44.4 (4)
Girls	0.0 (0)	50.0 (6)	50.0 (6)

*Based on International Obesity Taskforce Criteria with additional subdivision of lower and higher healthy weight groups.[19]

adjunct to delivering the most appropriate and individualised feedback strategy.

There are several limitations to acknowledge. Ethnic differences were not explored because a larger sample with more overweight/obese children would be required. Second, although there was a good parental response, we could not determine whether children of non-responders differed significantly on characteristics measured in the study. Parents of heavier children may have selected themselves out of the study, but school-wide data were not available to confirm this. The study also reports cross-sectional findings, although the children will be followed up annually for 3 years allowing comparisons of children who underestimate body size at baseline with those who are aware of their size.

CONCLUSION

These results indicate that children can estimate their body size with visual-matching and verbal-rating methods, but the degree of precision is moderated by weight status, with underweight children overestimating and heavier children, especially girls, underestimating body size. Findings from the verbal scale showed a tendency for children of all sizes to perceive themselves as "just right". With the visual task it was clear that most children, especially in the heavier groups, saw themselves as thinner than they were.

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Ethics approval: Ethical approval for the study was granted by the University College London Committee on the Ethics of Non-NHS Human Research.

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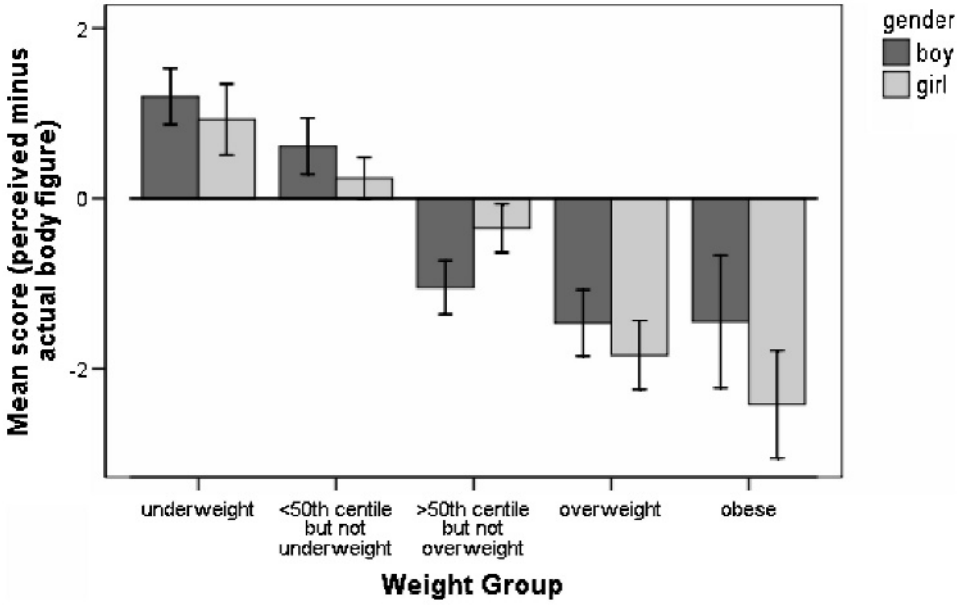

Figure 2 Mean inaccuracy (standard error) of body size perception using visual ratings.

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Archivist

Typhoid vaccine effectiveness in India

It is estimated that typhoid fever causes between 216 000 and 600 000 deaths each year, almost all in developing countries. The injectable Vi polysaccharide typhoid vaccine is cheap (50 US cents per dose) and potentially useful in developing countries. There have been questions, however, about programme feasibility, whether it is protective in young children (aged 2–5 years), and whether it is able to confer herd immunity. Now a study in Kolkata, India (Dipika Sur and colleagues. N Engl J Med 2009;**361**:335–44; see also editorial, ibid: 403–5) has provided some answers.

In a cluster-randomised trial, a total of 37 673 people living in slums and aged ⩾2 years were assigned to receive a single intramuscular dose of either Vi vaccine or inactivated hepatitis A vaccine and followed for 2 years. Vaccine coverage was 60% in each group. A diagnosis of typhoid fever during follow-up was made for 34/18 869 (1.8 per 1000) in the Vi vaccine group and 96/18 894 (5.1 per 1000) in the control group, giving a protective effectiveness of 61% on adjusted analysis. The protective effectiveness was 80% among children aged 2–4 years, 56% among children aged 5–15 years, and 46% among people aged >15 years. The level of protection was 44% among unvaccinated people living in Vi vaccine clusters and 57% among all residents of these clusters. No serious adverse events attributable to either vaccine were recorded during the month after vaccination.

The Vi vaccine was effective in young children and protected unvaccinated people in the cluster. Two typhoid vaccines are licensed and available; parenteral unconjugated Vi (single dose) and oral Ty21a (three doses). The Vi vaccine does not protect against paratyphoid. The Ty21a vaccine provides 49% protection against paratyphoid B but none against paratyphoid A. Greater use should be made of these vaccines.

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