ABSTRACT

Background

Associations between adolescent health-related quality of life (HRQol), bullying and aggression are not well understood. We used baseline data from a large cluster randomised school trial to study the relationship between HRQol, bullying experience and other demographic factors.

Methods

Design: cross sectional self-reported questionnaires collected pre-randomisation from the on-going INCLUSIVE trial. The questionnaires were completed in the classroom. The Gatehouse Bullying Scale (GBS) measured bullying victimization and the Edinburgh Study of Youth Transitions and Crime school misbehaviour subscale (ESYTC) measured aggressive behaviours. HRQol was assessed using the Child Health Utility 9 Dimensions (CHU-9D) and general quality of life using the Paediatric Quality of Life Inventory (PedsQL). Participants: cohort of year 7 students (age 11-12 years) from 40 state secondary schools in England.

Analysis: Descriptive statistics for the CHU-9D and PedsQL were calculated using standard methods with tests for differences in median scores by sex assessed using quantile regression. Correlation between HRQol measures was conducted using Spearman's rank correlation coefficients. Predictors of HRQol were identified using univariate and multiple regressions.

Results

6667 students filled out the questionnaire. The CHU-9D was correlated with the PedsQL (0.63, $p < 0.001$). The multivariable regression results suggest that if students ~~were bullied either frequently or upset, or~~were bullied frequently and upset it~~,~~ resulted in a decrement in CHU-9D scores of (~~-0.063 and -~~-0.108) ~~respectively~~ and fall in PedsQL score of (~~-9.5 and -~~-16.2) ~~respectively~~. The impact of the antisocial/aggressive behaviour on the ESYTC scale resulted in a utility decrement of -0.004 and fall of -0.5 on the PedsQL.

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Conclusions

Adolescents' involvement in bullying and aggression is a strong correlate of HRQol. These data have important implications for the potential cost-effectiveness of reducing bullying and aggression in schools.

KEYWORDS

Utility, CHU-9D, health-related quality of life, bullying, aggression

BACKGROUND

Bullying is commonplace and a serious public health issue. The World Health Organisation (WHO) issued a bulletin in 2010 highlighting the substantial harm that stems from repeated "physical and/or emotional aggression including teasing, name calling, mockery, threats, harassment, taunting, hazing, social exclusion or rumours" and calling for policy responses to address it [1]. Bullying affects children and adults alike, but it is perhaps most detrimental to children since it occurs at a crucial stage of development. The effects of school bullying are far-reaching and have been shown to impact quality of life [1]. The health effects associated with bullying manifest both physically and psychologically, often persisting into adulthood [2,3]. Bullied children are more likely to exhibit difficulties adjusting [4], social problems [5], and physical health issues [6,7]. Moreover, both bullies and victims have higher odds of suicide ideation and behaviour than peers [8]. These adverse effects likely contribute to one's health-related quality of life (HRQol).

Several recent studies demonstrate the negative relationship between bullying and HRQol in young children [9], in adolescents [9-11], and in adults who were bullied in their youth [3]. Although findings of an inverse or negative correlation between bullying and HRQol are consistent among the studies of which we are aware, the methods underlying these findings differ. The perspectives and instruments for measuring HRQol vary as do the environmental contexts of the study populations. For example, in 2011, a Norwegian study reporting a significantly lower HRQoL for bullied children and adolescents compared to their unbullied peers used the "Norwegian version of the KIDSCREEN-52 index" to measure HRQol [9]. Similar studies finding a negative association between bullying and HRQol in Swedish and Australian adolescents were conducted using the Medical Outcomes Study 36-item short-form health survey and the Dartmouth COOP Functional Health Assessment Charts for Adolescents, respectively [10,11]. However none of the aforementioned HRQol measures

directly generate utility values (although conversion algorithms exist for some measures), unlike the Child Health Utility 9 Dimensions (CHU-9D) used in this analysis.

The CHU-9D was created specifically for economic evaluation purposes within the childhood context ~~The CHU-9D was created specifically for use in economic evaluation of cost-effectiveness~~ [12]. To that end, its scoring algorithm directly generates utility values. These values can be combined with mortality data for the estimation of a generic index measure, such as the quality adjusted life year (QALY) [12]. The benefit of a single generic index measure is that it allows for comparison of interventions' cost-effectiveness across disease areas, an approach advocated by the ~~United Kingdom's~~ National Institute for Health and Care Excellence (NICE) [13]. In addition, the CHU-9D was developed by soliciting children's own views of the dimension of life impacting their wellbeing, although the valuations are by adults [14].

This study assesses ~~the~~ the extent to which there is an association between childhood bullying and HRQol in English schoolchildren using baseline trial data collected as part of the INCLUSIVE randomised controlled trial (INCLUSIVE) [15]. We examined the extent experiencing bullying and involvement in aggressive behaviour is associated with a reduction in utility scores and HRQol. Estimation of utility scores is potentially important for future economic evaluations of interventions targeted at bullying to determine cost-effectiveness in terms of incremental cost per QALY gained. ~~Estimation of utility scores is potentially important for future economic evaluations of bullying interventions to determine cost-effectiveness in terms of cost per QALY~~. To our knowledge, this is the first study to evaluate an association between bullying experience and quality of life in the form of utilities using the CHU-9D.

METHODS

Ethical approval

Ethical approval was granted through the London School of Hygiene & Tropical Medicine (LSHTM) Ethics Committee (reference 8952), the University College London's Institute of Education (IOE) Ethics Review Committee (FCL 566), and the University College London (UCL) Research Ethics Review Committee (Project ID 5248/001).

INCLUSIVE trial

INCLUSIVE is an on-going cluster randomised controlled trial assessing the effectiveness and cost-effectiveness of the Learning Together intervention in reducing aggression and bullying in English secondary schools [1]. The trial provides comprehensive data from a cohort of year 7 students (aged 11 to 12 years) at baseline on experiences of violence and bullying as well as HRQol. The INCLUSIVE trial includes 40 secondary schools within the state education system across south-east England. Schools exclusively for those with learning disabilities, pupil referral units and schools with an Ofsted rating of 'inadequate/poor' were not included in the sample. Full details of the sampling methodology are available in the study protocol [15]. Data pertinent to this cross-sectional study were collected at the trial baseline prior to allocation of schools to intervention or comparator by student survey self-reports between April and July 2014. Paper-based questionnaires were completed in a classroom setting with trained researchers, fieldworkers, and teachers overseeing. A verbal explanation and consent forms were provided before distribution of the questionnaires; only those students who gave written consent participated in the survey. In 2012, a pilot study was conducted in eight schools where all survey instruments were developed and tested [16].

Quality of life measures

Quality of life was measured using both the CHU-9D and PedsQL instruments.

Child Health Utility 9D

Developed in 2011, the CHU-9D was "specifically designed [to measure HRQol] for the economic evaluation of healthcare treatment and preventive programmes targeted at young people" [12]. Investigators preferred its component dimensions' relevance to adolescents and its reliance on children's input for the development of its classification system [16]. The CHU-9D includes nine dimensions (worried, sad, pain, tired, annoyed, sleep, school, daily routine, and activities), with each represented by a single question with five response options.[17] Response options are on a Likert scale assessing the strength of a feeling or the frequency of an event experienced today. CHU-9D scores are calculated using a utility algorithm that produces values between zero (equivalent to being dead) and one (representing perfect health). This algorithm values each health state (corresponding with a CHU-9D score) according to preference weights elicited from the UK adult population using the standard gamble approach. In addition, we explored as a secondary analysis the implications of using weights elicited from Australian adolescents using best worst case scaling methods [12].

Paediatric Quality of Life Inventory

The Paediatric Quality of Life Inventory (PedsQL) measure has shown to be reliable for assessing adolescent HRQol in school-based settings [18]. It consists of 23 items encompassing four functional dimensions: physical, emotional, social, and school. Respondents select an answer from five choices on a Likert scale based on the frequency of specified events' occurrence over the past month; choices range from "never" to "almost always" [19]. We used the Generic Core Scales, and applied the child self-report version

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targeted at 8-12 year olds. The PedsQL produces an overall score ranging between zero and 100.

Other measures

Data on students' experiences with violence were collected through two measures—one measuring bullying victimisation and the other measuring perpetration of aggressive behaviours.

Gatehouse Bullying Scale

The Gatehouse Bullying Scale (GBS) includes 12 questions that measure bullying victimisation. Notably, it does not specifically ask whether respondents have been bullied; rather, it asks "whether they have been teased or called names, had rumours spread about them, been deliberately left out of things, and had recently been physically threatened or hurt" over the last three months [20]. Respondents are considered to be "bullied" if they have recently been subjected to any of the negative behaviours [20]. The score is on a scale between zero and three, with zero indicating that the student has not been bullied. Scores between one and three identify "increasing intensity (frequency and level of upset) of one or more of the four types of bullying" [16].

Edinburgh Study of Youth Transitions and Crime school antisocial/aggressive behaviour subscale

The Edinburgh Study of Youth Transitions and Crime school antisocial/aggressive behaviour subscale (ESYTC) is comprised of 13 items probing respondents about aggression and violence in the school environment. Participants are asked about the frequency with which they committed acts of misbehaviour or received disciplinary action at school over the last three months. Responses were coded on a scale ranging from zero to three (i.e., 0=Most days; 1=At least once per week; 2=Less than once per week; 3=Hardly ever or never). Total

scores are a summation of the frequency of antisocial or aggressive behaviour. Higher scores represent more school misbehaviour [16].

Validity of bullying and aggression measures

To assess the validity of these measures, the pilot study undertook consultation with young people to explore views on how to define bullying and aggression and whether the INCLUSIVE study's measures were appropriate and acceptable [16]. In addition, the perspectives of young researchers were solicited. This group expressed some concerns with both questionnaires since they felt that some questions were too extreme (e.g. stabbing someone), poorly defined (e.g. verbal bullying), or ubiquitous (e.g. using bad language) to produce honest and meaningful distinctions between student experiences. However, in general, these measures were felt to be appropriate for the study.

Demographic information

Information was collected on students' age, sex, ethnicity, religion, family structure, parental employment, housing tenure, and family affluence. Socio-economic status was estimated using parental employment, housing tenure, and asset ownership/consumption as proxies for household income. Questions about asset ownership and consumption - car ownership, children having private bedrooms, number of computers owned, and the number of holidays taken in the past 12 months - contributed to an overall Family Affluence Scale (FAS). FAS scores between zero and two are considered low affluence; scores between three and five indicate middle affluence; and scores between six and nine signify high affluence [21]

Statistical analysis

Analyses were carried out in STATA 13 (Stata Corporation, College Station, TX, USA) and were adjusted for clustering at the school level where possible [15]. Descriptive analysis of quality of life score and bullying experience scores were performed. Association between

quality of life score from both instruments was assessed using Spearman's rank correlation coefficient. Univariate and multivariable regression models were applied to identify predictors of HRQol. Sex differences in HRQol and bullying experience were explored by use of formal interaction test since recent studies have suggested that boys and girls may be dissimilar in several areas contributing to HRQol [10,9]. All statistical tests were two-tailed and considered only complete cases for each applicable element.

Descriptive statistics

Response tabulations, percentages, mean scores and standard deviations (SD), and medians and interquartile ranges (IQR) for skewed data were calculated overall and by sex. Significance tests for differences in medians by sex were conducted using quantile regression tests since data was non-normally distributed and cluster adjustments are permitted.

Comparison of quality of life measures

The correlation between two measures of HRQoL for children, the CHU-9D and the PedsQL, was assessed. A Spearman's rank correlation coefficient was calculated to assess whether the ranks of the two measures co-vary. In short, this correlation coefficient measures the extent to which the rank order of CHU-9D utility varies with the total PedsQL score's rank order.

Predictors of health-related quality of life

Linear regression models were fitted to analyse the relationship between HRQol (as measured by CHU-9D) and an array of independent variables. As a first step, univariate regression was performed with HRQol as the main outcome of interest. A univariate regression was conducted with each independent variable to examine associations with HRQol. Indicator variables were used for the following categorical variables: ethnicity,

religion, family structure, parental employment, and housing tenure. This compared the effect of each level to a specified reference group. The level with the highest proportion of students was selected as the reference group.

After examining all univariate relationships, a multivariable model was constructed to determine the combination of variables that best predict HRQol. The first step fitted a full model with all independent variables considering utility score as the outcome of interest. Variables found not to be significant in the univariate stage were dropped from the model with the exception of established influencers of HRQol, namely age and socio-economic status [9] . When there was evidence of non-normality in the continuous outcome measure (i.e., CHU-9D score), the non-parametric bootstrap method with 2000 samples was used to estimate the effect of bullying experience and other socio-demographic variables on HRQol and resulting bias corrected CI were reported. The model specification was checked using the Ramsay reset test.

In addition, we conducted further regression analysis because the CHU-9D data showed a spike at 1.0 indicating a high proportion of adolescents reporting perfect heath. For this reason we also fitted a two part regression model as a secondary analysis. First, a logistic model was performed, in which the dependent variable indicated perfect health (yes or no). Then we conducted a general linear model for the data relating to people with less than perfect health was a γ distribution and log link because of the left skewed nature of the data. In this analysis, positive effect estimates indicate poorer health whereas negative values indicate better health. Furthermore, there could potentially be joint effects of victimisation and perpetration of aggressive behaviour on health-related quality of life outcomes; to explore this we ran the OLS model with either the GBS bullying victimization score or the ESYTC antisocial/aggressive behaviour score incorporated separately.

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RESULTS

A total of 6,667 students participated in the INCLUSIVE baseline survey. Table 1 shows the socio-demographic characteristics of these students. A higher proportion of the students were is female (52%) and White British (39%). A vast majority of the students wereis from a two-parent family structure with about 70% having at least one parent in active employment and mostly living in privately owned housing.

[INSERT TABLE 1 ABOUT HERE]

A descriptive summary of both CHU-9D and PedsQL scores is are shown for the overall sample and by sex in Table 2. 92% of respondents completed all CHU-9D elements while 96% finished all PedsQL questions, this may be partially explained by the fact that the PedsQL was administered first in the questionnaire. Students reported a mean CHU-9D utility score of 0.88 (SD 0.10) with possible values ranging between zero and one. However, when the Australian utility weights were used that had been derived from adolescents the mean scores were lower 0.77 (SD 0.002).The overall mean PedsQL mean score was 80.67 (SD 14.24) out of a maximum score of 100. With both measures, higher scores indicate better quality of life. Notably, females scored lower overall for both measures. Since both measures were non-normally distributed, significance tests for difference in medians across sex was performed. Median PedsQL did not differ by sex (p=0.158; 95% CI: -1.770, 0.287). However, CHU-9D showed evidence of a difference in median utility scores by sex (p=0.014; 95% CI: -0.017, -0.002).

[INSERT TABLE 2 ABOUT HERE]

A descriptive summary of both GBS and ESYTC scores for the overall sample are shown in Table 3. The mean GBS score of 1.09 (SD 1.04) shows that on average most adolescents

were subjected to at least one form of negative behaviour. The ESYTC mean score was 2.81 (SD 4.81) indicating that on average most students ha~~ve~~d some experience of misbehaving at school. Mean or median GBS and ESYTC scores didn't differ by sex, and therefore these scores were not stratified by sex.

[INSERT TABLE 3 ABOUT HERE]

A histogram showed the distribution of CHU-9D utility scores to be left-skewed (Figure 1). The mean utility score was 0.88 (SD 0.10) with a median of 0.90 (Interquartile range 0.82, 0.95). Further assessment of the sub-scales of the CHU-9D showed that experience of problems with bullying had a significant effect on quality of life for all domains (See appendix Table 1).

 [INSERT FIGURE 1 ABOUT HERE]

To evaluate the association between the two measures of QoL, a Spearman's rank correlation test was performed, which revealed a strong positive correlation between CHU-9D utility scores and overall PedsQL scores (0.63, $p < 0.0001$). This indicates that as the ranks of PedsQL scores increased so too did the CHU-9D utility score.

Results of univariate regression analysis presented in Table 4 show that there is a 0.037-point decrease in utility score for every one-point increase in GBS bullying victimisation score. Similarly, utility decreases by 0.005 points for every one-point increase in ESYTC antisocial/aggressive behaviour score. In addition, the following variables were identified as significant predictors of higher HRQol: sex (males compared to females); ethnicity (Asian/Asian British, Black/Black British, and Other compared to White British); religion (None, Jewish, Don't know compared to Christian); and family structure (Single mother and Reconstituted compared to Two parents).

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[INSERT TABLE 4 ABOUT HERE]

A multivariable linear regression model was fitted to explore the variables that best explain utility scores using the CHU-9D and PedsQL when considered jointly. The regression model was performed using 5,412 complete cases (81% of respondents), which represent students who answered all survey questions used in this analysis in their entirety. The multivariable regression model adjusted for baseline covariates shown to be significantly related to HRQol in the univariate stage: GBS bullying victimization score, ESYTC antisocial/aggressive behavior score, and socio-demographic characteristics (age, gender, ethnicity, family structure, and housing tenure). To address potential problems of multicollinearity, only one indicator of socio-economic status - housing tenure - was kept in the model. In the same way, religion was dropped from the final model in favour of ethnicity. Religion was selected for removal because it had the fewest number of students in any given level (Jewish, N=22).

The final multi-variable model illustrates the change in CHU-9D utility score and PedQL related with a change in the independent variable while controlling for all others included in the model (Table 5). We found no evidence on the Ramsay reset test that the model was misspecified. The results suggest that if students were bullied but not frequently and not upset, bullied either frequently or upset, or bullied frequently and upset, resulted in decrements in CHU-9D scores of -0.036, -0.063 and -0.108, respectively, and decrements in PedsQL scores of -4.7, -9.5 and -16.2, respectively.resulted in a decrement in CHU-9D scores of (-0.036, -0.063 and -0.108) respectively and fall in PedsQL score of (-4.7, -9.5 and 16.2) respectively. The impact of the antisocial/aggressive behaviour on the ESYTC scale resulted in a utility decrement of -0.004 and fall of -0.5 on the PedsQL.

Further analysis exploring an alternative multivariate regression structure with a generalized linear model found similar findings to the ordinary least squares approach (See appendix Table 2). In addition, alternative specifications of the model with either the GBS bullying

victimization score or the ESYTC antisocial/aggressive behaviour score incorporated separately into the multivariable models found very similar results (See appendix Table 3).

Analysis using Australian values collected from adolescents for the CHU-9D had a considerable impact on results. These showed students bullied either frequently or upset or bullied frequently and upset, resulted in a decrement in CHU-9D scores of (-0.137 and -0.225) respectively. This reflects the overall lower CHU-9D scores when valued by an adolescent population rather than adults.

There was also evidence that females experience slightly lower health-related quality of life when controlling for all other variables. Interestingly, ethnicity was significantly related to utility scores when controlling for bullying experience, age, sex, family structure, and housing tenure. Specifically, most ethnic groups -non-British White, Asian, Black, and unclassified "other" students - experienced higher health-related quality of life compared to their White British peers ($p \leq 0.05$).

[INSERT TABLE 5 ABOUT HERE]

DISCUSSION

Summary of main findings

In this study, we explored descriptive associations and predictors of HR-QoI set in the context of bullying and aggression in secondary school children rather than attempting to assess causality. All statistical analyses consistently showed that children who were bullied or who behaved aggressively at school experienced lower health-related quality of life and utility scores compared to their peers. The multivariable analysis confirmed these relationships as independent of included potential confounders, while revealing that female sex and White British ethnicity (compared to most other ethnicities) were also independently associated with lower CHU-9D utility scores.

Bullying victimisation and perpetration of aggressive behaviour were highly significant predictors of HRQol and utility scores. For example, students reporting being bullied frequently and upset had a -0.1 (on a scale 0-1) decrement in CHU-9D utility scores and a -16 fall in PedsQL score (out of 100). The multiple regression model indicated that increased subjection to bullying and/or increased school antisocial/aggressive behaviour were associated with lower HRQol after controlling for all other covariates (Table 5). This study found 61.7% of students reported being the victim of at least one form of bullying over the past three months (e.g., teasing, rumours, exclusion, or physical threats/violence), and 15.8% of students admitted to hitting or kicking another student over the same period. These findings are supported by a recent study of children in 15 countries, which found that over 30% of children in the UK were hit by another at school and 50% were intentionally left out during the preceding month [22].The pervasiveness of bullying and its association with lower HRQol and other health problems make it an important public health problem [2,7-9].

The multivariable model provided several noteworthy findings (Table 5). For example, females were shown to experience slightly lower HRQol. This is consistent with a variety of other studies that suggest for young adolescents that this may be due factors such as societal expectations of women and girls also experience more bodily pain and rate their general health as worse than boys do. [10,23]. Indeed, a 2009 multinational study found that "girls showed a more profound decrease in [HRQol] with increasing age" [23]. Another surprising findings from this INCLUSIVE study revealed higher HRQol associated with most minority ethnicities (compared to White British).

To our knowledge, this is the first study to evaluate experience of bullying victimisation and aggressive behaviour as predictors of health-related quality of life using an instrument that directly estimates utility values. Despite the different methods, previous studies have found similar results with respect to lower HRQol associated with females, bullying victims, and aggressive behavior [9-11,23]. However unlike our study, these did not measure utility.

Limitations

This study has several limitations related to the chosen measures of HRQol and bullying experience as well as to its generalisability.

A key limitation of this study is that it relies on cross sectional data which makes it difficult to identify whether bullying and aggression are causes or consequences of decrements in health-related quality of life. It is not clear whether poorer health generally, make it more likely to of experienceing bullying or aggressive behaviour. These concerns are very difficult to tease out of the analysis.

The CHU-9D is a recently developed measure of HRQol that has several key advantages, chief among which is that it incorporates societal preferences directly in its scoring to

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produce utility values for economic evaluations. However, the scoring algorithm used for this purpose does not directly reflect the preferences of this study's population (UK adolescents). In the absence of CHU-9D preference weights for UK adolescents, this analysis relied upon health state valuations from a UK adult population. In our secondary analysis utilizing values from Australian adolescents we found a much greater impact of bullying and aggression on utility scores. Presently, research is being conducted to develop methods of eliciting health state preferences from UK adolescents for use with the CHU-9D [26]. Future analyses of HRQol in adolescent populations will benefits from this on-going work.

Furthermore, the CHU-9D's recall period may limit is applicability. The CHU-9D asks individuals to rate their function or feelings today [27]. Because the recall period (one day) is so short, the measure may be insensitive to issues that irregularly affect respondents. For example, a recent study investigating the measure's use in children receiving mental health services found that asking about today may have underestimated estimations of dysfunction because today was atypical in some way [28]. As relates to the INCLUSIVE trial, the CHU-9D may minimise estimated differences in HRQol related to bullying victimisation and school antisocial/aggressive behaviour since these behaviours often do not occur on a daily basis. Refining the CHU-9D's recall period to "a typical day" as suggested by Furber and Segal may alleviate this issue [28]. The recall period for the PedsQL is longer at one month and potentially this could lead to different findings.

Measurement of bullying perpetuation was not possible using data collected in the INCLUSIVE trial. Instead, the trial used the ESYTC school antisocial/aggressive behaviour scale, which asked students to report a variety of discipline problems involving other students and staff. While this measure may provide an indication of a student's propensity to bully, it does not directly assess it. Other studies have found significantly reduced HRQol reported

among bullies and bully-victims (i.e., those who both give and receive negative bullying behaviours) [10]. This study was not able to replicate these types of analyses.

The applicability of this study's findings to other contexts is constrained by several aspects. First, INCLUSIVE's focus on state-sponsored secondary schools in London and its environs makes extrapolation of these results to other settings potentially unsuitable. It is unknown whether observed relationships extend to rural populations or to adolescents attending private educational institutions, for example. Additionally, the impact of age could not be considered in this analysis because the study population is a cohort of students in the same school year. As a result, age varied very little, and its association with HRQol could not be assessed.

Implications for research and policy

The result of this study could be used in future economic evaluations of bullying interventions. Economic evaluation seeks to assess cost-effectiveness by comparing interventions in terms of their costs and consequences. Results presented in this study address consequences: quantifying the average loss in HRQol related to bullying victimisation and school antisocial/aggressive behaviour. However, HRQol does not fully capture all consequences associated with bullying and aggressive behaviours. Effects likely extend to the social, educational, and criminal justice spheres as well [16]. To address this broad scope, future evaluation of the INCLUSIVE intervention will adopt NICE's methodology for assessing complex public health interventions through cost-consequence analysis [29,15]. A distinct challenge to this analysis will be measurement of the intervention's impact on equity. Because we are evaluating a universal intervention aimed at altering the social fabric of secondary schools, it is prudent to consider equity implications thoroughly. The relationship between health-related quality of life and various aspects of relative

disadvantage identified above and its interplay with bullying experience deserve particular attention.

CONCLUSIONS

Bullying experience has been shown to have an important negative association with HRQol. There is an ongoing focus on finding interventions able to demonstrate a sustainable and cost effective solution to bullying. Future assessment of cost-effectiveness of such interventions will need to take this significant impact on utility into account.

LIST OF ABBREVIATIONS USED

95% CI	95% confidence interval
CHU-9D	Child Health Utility 9 Dimensions
ESYTC	Edinburgh Study of Youth Transitions and Crime school antisocial/aggressive behaviour subscale
GBS	Gatehouse Bullying Scale
HRQol	Health-related quality of life
INCLUSIVE	Initiating change locally in bullying and aggression through the school environment
IOE	Institute of Education
IQR	Interquartile range
LSHTM	London School of Hygiene & Tropical Medicine
NICE	National Institute for Health and Clinical Excellence

PedsQL	Paediatric Quality of Life Inventory
QALY	Quality-adjusted life year
SD	Standard deviation
SE	Standard error
UCL	University College London
UK	United Kingdom
WHO	World Health Organisation

COMPETING INTERESTS

None declared.

AUTHORS' CONTRIBUTIONS

RL,RG,DC,AF,EA, CB and RV designed the trial and data collection. CF, EA, ZS, CO, AM, advised on the design of the statistical analysis. CF and ZS undertook all analyses under the supervision of RL. All authors were responsible for drafting the manuscript.

AUTHORS' INFORMATION

CF undertook the initial analysis of this project as part of her MSc project dissertation.

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ILLUSTRATIONS AND FIGURES

Fig.1 Distribution of CHU-9D utility scores

[SEE SEPARATE FILE *Fig 1 CHU9D histogram.PPT*]

TABLES AND CAPTIONS

Table 1. Socio-Demographic characteristics

Characteristics	
AGE - mean (SD)	11.75 (0.43)
SEX - n (%)	
Male	3,103 (46.5)
Female	3,453 (51.8)
ETHNICIITY – n (%)	
White British	2612 (39.2)
White other	564 (8.5)
Asian/Asian British	1645 (24.7)
Black/Black British	919 (13.8)
Chinese/Chinese British	46 (0.7)
Mixed ethnicity	462 (6.9)
Other	338 (5.1)
RELIGION - n (%)	
None	1770 (26.6)
Christian	2246 (33.7)
Jewish	22 (0.3)
Muslim/Islam	1695 (25.4)
Hindu	266 (4.0)
Sikh	159 (2.4)
Don't know	271 (4.1)
Other	173 (2.6)
FAMILY STRUCTURE – n (%)	
Two parents	4762 (71.4)
Single mother	1230 (18.5)
Single father	93 (1.4)
Reconstituted	450 (6.8)
Other	81 (1.2)
PARENTAL EMPLOYMENT – n (%)	
No	522 (7.8)
Yes	4818 (72.3)
Don't know	1198 (18.0)
HOUSING TENURE – n (%)	
Social rented	1033 (15.5)
Private rented	787 (11.8)
Private owned	2724 (40.9)
Other	121 (1.8)
Don't know	1863 (27.9)
FAMILY AFFLUENCE SCALE – mean (SD)	6.07 (1.83)

* Overall total differs from sum of male and female responses because some students failed to provide sex information and/or responses to demographic questions
Percentages shown to one decimal place; means and SDs are shown to two decimal places.

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Table 2. Quality of life scores overall and by sex

	MALES	FEMALES	OVERALL
	Mean (SD) *Median (IQR)*	Mean (SD) *Median (IQR)*	Mean (SD) *Median (IQR)*
Health Utility – Child Health Utility 9D (CHU-9D)			
CHU9D overall score (N=6026)	0.88 (0.10) *0.90 (0.83, 0.95)*	0.87 (0.11) *0.89 (0.81, 0.95)*	0.88 (0.10) *0.90 (0.82, 0.95)*
Quality of Life – Paediatric Quality of Life Inventory (PedsQL)			
PedsQL overall score (N=6337)	81.28 (14.08) *83.70 (73.91, 92.39)*	80.13 (14.35) *82.95 (71.74, 91.30)*	80.67 (14.24) *83.70 (72.83, 91.30)*

Table 3. Bullying experience scores

	Mean (SD) *Median (IQR)*
Bullying victimisation – Gatehouse Project Bullying Scale (GBS)	
GBS overall score (N=6287)	1.09 (1.04) *1.00 (0.00, 2.00)*
Teasing	0.76 (0.97)
Rumours	0.51 (0.83)
Deliberate exclusion	0.40 (0.80)
Threatened or hurt	0.33 (0.71)
Antisocial behavior – Edinburgh Study of Youth Transitions and Crime (ESYTC)	
ESYTC overall score (N=6172)	2.81 (4.81) *1.00 (0.00, 3.00)*

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Table 4. Univariate analysis of factors associated with the CHU-9D

	COEFFICIENT	BIAS CORRECTED SE	BIAS CORRECTED 95% CI
GBS BULLYING VICTIMISATION SCALE			
Not bullied (reference)			
Bullied but not frequently and not upset	-0.040	0.003	-0.046,-0.034*
bullied either frequently or upset	-0.073	0.003	-0.079,-0.066*
bullied frequently and upset	-0.114	0.006	-0.125,-0.101
ESYTC SCHOOL ANTISOCIAL BEHAVIOUR SCALE	-0.005	0.001	-0.006, -0.004*
AGE	0.006	0.003	-0.0005, 0.0112
SEX (M=1, F=2)	-0.015	0.004	-0.023, -0.008*
ETHNICITY			
White British (reference)	•••	•••	•••
White other	0.010	0.006	-0.003, 0.019
Asian/Asian British	0.016	0.005	0.006, 0.025*
Black/Black British	0.023	0.006	0.012, 0.034*
Chinese/Chinese British	-0.006	0.018	-0.037, 0.033
Mixed ethnicity	0.005	0.006	-0.008, 0.016
Other	0.017	0.006	0.006, 0.028*
RELIGION			
Christian (reference)	•••	•••	•••
None	-0.012	0.005	-0.022, -0.003*
Jewish	-0.085	0.043	-0.202, -0.027*
Muslim/Islam	0.005	0.005	-0.006, 0.014
Hindu	0.014	0.008	-0.001, 0.029
Sikh	-0.001	0.010	-0.019, 0.022
Don't know	-0.021	0.006	-0.034, -0.010*
Other	-0.005	0.007	-0.020, 0.009
FAMILY STRUCTURE			
Two parents (reference)	•••	•••	•••
Single mother	-0.008	0.004	-0.016, -0.001*
Single father	-0.020	0.011	-0.042, 0.003
Reconstituted	-0.019	0.005	-0.030, -0.010*
Other	-0.007	0.015	-0.041, 0.020
PARENTAL EMPLOYMENT			
Yes (reference)	•••	•••	•••
No	-0.006	0.005	-0.016, 0.003
Don't know	0.002	-0.0002	-0.006, 0.010
HOUSING TENURE			
Private owned (reference)	•••	•••	•••
Social rented	0.005	0.005	-0.005, 0.014
Private rented	0.000	0.004	-0.007, 0.008
Other	0.000	0.011	-0.025, 0.020
Don't know	0.005	0.003	-0.0001, 0.011
FAMILY AFFLUENCE SCALE	-0.001	0.001	-0.002, 0.001

For all factors with multiple levels, each one is compared to the reference category indicated. Negative coefficients indicate worse health-related quality of life while positive values indicate better HRQol.
* Significant at the 5% level.

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Table 5. Multivariable analysis of factors associated with health-related quality of life

	CHU-9D			PEDSQL	
	COEFFICIENT	BIAS CORRECTED 95% CI		COEFFICIENT	BIAS CORRECTED 95% CI
GBS BULLYING VICTIMISATION SCALE					
Not bullied (reference)	•••	•••		•••	•••
bullied but not frequently & not upset	-0.036	-0.041-0.030*		-4.739	-5.773, -3.704*
bullied either frequently or upset	-0.063	-0.070,-0.056*		-9.480	-10.599,-8.361*
bullied frequently and upset	-0.108	-0.120,-0.096*		-16.212	-17.702,-14.723*
ESYTC SCHOOL ANTISOCIAL/AGGRESSIVE BEHAVIOUR SCALE	-0.004	-0.005,-0.003*		-0.514	-0.651,-0.378*
AGE	0.005	-0.001, 0.011		0.720	-0.001,1.441
SEX (M=1, F=2)	-0.017	-0.024,-0.009*		-1.124	-1.951,-0.298*
ETHNICITY					
White British (reference)	•••	•••		•••	•••
White other	0.015	0.005, 0.025*		1.027	-0.348,2.403
Asian/Asian British	0.013	0.004, 0.021*		-0.216	-1.214,0.783
Black/Black British	0.031	0.022, 0.040*		2.809	1.292,4.327*
Chinese/Chinese British	-0.018	-0.045, 0.010		-3.326	-6.733,0.081
Mixed ethnicity	0.011	-0.001, 0.024		1.509	0.035,2.982
Other	0.018	0.005, 0.031		2.370	0.735,4.004
FAMILY STRUCTURE					
Two parents (reference)	•••	•••		•••	•••
Single mother	-0.005	-0.012, 0.002*		-1.638	-2.582,-0.694*
Single father	-0.000	-0.024, 0,023		-1.138	-4.684,2.408
Reconstituted	-0.010	-0.021, 0.001		-2.266	-3.640,-0.893*
Other	0.028	0.004, 0.053		2.930	-0.165,6.025
HOUSING TENURE					
Private owned (reference)	•••	•••		•••	•••
Social rented	0.009	0.001, 0.018*		-1.170	-2.288,-0.051
Private rented	0.004	-0.003, 0.010*		-0.245	-1.619,1.129
Other	0.007	-0.018, 0.031		-0.919	-4.791,2.953
Don't know	0.003	-0.003, 0.009*		-1.581	-2.416,-0.746

Commented [rl1]:

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OBSERVATIONS: 5412	5633
CONSTANT: 0.867	80.0

For all factors with multiple levels, each one is compared to the
reference category indicated. Negative coefficients indicate worse
health-related quality of life while positive values indicate better HRQol.
Coefficients represent the change in utility score associated with a
change in each independent variable while controlling for all others
included above.
* Significant at the 5% level.

Appendix

Appendix table 1

CHU9D responses.	No Bullying Frequency (%)	Any bullying Frequency (%)	P Value
Worried	-	-	-
I don't feel worried today	1909 (82.1)	2260 (60.6)	
I feel a little bit worried today	287 (12.3)	863 (23.1)	
I feel a bit worried today	81 (3.5)	320 (8.6)	
I feel quite worried today	35 (1.5)	169 (4.5)	
I feel very worried today	14 (0.6)	118 (3.2)	0.001
Sad	-	-	-
I don't feel sad today	2090 (90.0)	2563 (68.7)	
I feel a little bit sad today	163 (7.0)	648 (17.4)	
I feel a bit sad today	44 (1.9)	249 (6.7)	
I feel quite sad today	15 (0.7)	153 (4.1)	
I feel very sad today	11 (0.5)	116 (3.1)	0.001
Pain	-	-	-
I don't have any pain today	1832 (78.9)	2277 (61.1)	
I have a little bit of pain today	343 (14.8)	860 (23.1)	
I have a bit of pain today	95 (4.1)	356 (9.6)	
I have quite a lot of pain today	35 (1.5)	146 (3.9)	
I have a lot of pain today	18 (0.8)	90 (2.4)	0.001
Tired	-	-	-
I don't feel tired today	891 (38.3)	958 (25.6)	
I feel a little bit tired today	846 (36.3)	1285 (34.4)	
I feel a bit tired today	297 (12.8)	644 (17.2)	
I feel quite tired today	179 (7.7)	455 (12.2)	
I feel very tired today	115 (4.9)	395 (10.6)	0.001
Annoyed	-	-	-
I don't feel annoyed today	1970 (84.7)	2385 (63.8)	
I feel a little bit annoyed today	239 (10.3)	730 (19.5)	
I feel a bit annoyed today	64 (2.8)	282 (7.5)	
I feel quite annoyed today	29 (1.3)	172 (4.6)	
I feel very annoyed today	24 (1.0)	169 (4.5)	0.001
Schoolwork/Homework	-	-	-
I have no problems with my schoolwork/homework today	1810 (77.9)	2313 (62.2)	
I have a few problems with my schoolwork/homework today	390 (16.8)	908 (24.4)	
I have some problems with my schoolwork/homework today	90 (3.9)	340 (9.1)	
I have many problems with my schoolwork/homework today	20 (0.9)	102 (2.7)	
I can't do my schoolwork/homework today	14 (0.6)	57 (1.5)	0.001

Appendix table 1 cont/d

CHU9D responses.	No Bullying Frequency (%)	Any bullying Frequency (%)	P Value
Sleep	-	-	-
Last night I had no problems sleeping	1661 (71.3)	1954 (52.4)	
Last night I had a few problems sleeping	440 (18.9)	943 (25.3)	
Last night I had some problems sleeping	140 (6.0)	444 (11.9)	
Last night I had many problems sleeping	50 (2.2)	219 (5.9)	
Last night I couldn't sleep at all	39 (1.7)	172 (4.6)	0.001
Daily Routine	-	-	-
I have no problems with my daily routine today	2120 (91.3)	2916 (78.6)	
I have a few problems with my daily routine today	162 (7.0)	559 (15.1)	
I have some problems with my daily routine today	29 (1.3)	157 (4.2)	
I have many problems with my daily routine today	8 (0.3)	37 (1.0)	
I can't do my daily routine today	3 (0.1)	39 (1.1)	0.001
Able to join in activities	-	-	-
I can join in with any activities today	1830 (79.0)	2359 (63.8)	
I can join in with most activities today	271 (11.7)	668 (18.1)	
I can join in with some activities today	100 (4.3)	275 (7.4)	
I can join in with a few activities today	55 (2.4)	209 (5.7)	
I can join in with no activities today	61 (2.6)	185 (5.0)	0.001

Any bullying = score of 1 or more on GBS bullying scale

Appendix Table 2

Alternative specifications of the OLS model with Australian adolescent valuations of the

	CHU-9D –Australian adolescents			GLM modelling using Adult valuation CHU-9D	
	COEFFICIENT	**BIAS CORRECTED 95% CI**		**COEFFICIENT** **	**95% CI**
GBS BULLYING VICTIMISATION SCALE					
Not bullied (reference)	•••	•••		•••	•••
bullied but not frequently & not upset	-0.075	-0.087,-0.064*		0.036	0.031,0.0411*
bullied either frequently or upset	-0.137	-0.150,-0.123*		0.063	0.057,0.070*
bullied frequently and upset	-0.225	-0.247,-0.204*		0.107	0.095,0.119*
ESYTC SCHOOL ANTISOCIAL/AGGRESSIVE BEHAVIOUR SCALE	-0.008	-0.009,-0.006*		0.004	0.003,0.005*
AGE	0.010	-0.002,-0.022		-0.005	-0.011,0.001
SEX (M=1, F=2)	-0.038	-0.053,-0.024*		0.017	0.011,0.024*
ETHNICITY					
White British (reference)	•••	•••		•••	•••
White other	0.030	0.009,0.050*		-0.016	-0.027,-0.006*
Asian/Asian British	0.026	0.008,0.043*		-0.013	-0.021,-0.005*
Black/Black British	0.061	0.043,0.079		-0.033	-0.041,-0.024*
Chinese/Chinese British	-0.038	-0.090,0.014		0.014	-0.012,0.040
Mixed ethnicity	0.022	-0.004,0.045		-0.012	-0.025,0.001*
Other	0.031	0.007,0.055*		-0.018	-0.030,-0.006*
FAMILY STRUCTURE					
Two parents (reference)	•••	•••		•••	•••
Single mother	-0.010	-0.022,0.003		0.006	-0.001,0.013
Single father	-0.003	-0.054,0.047		0.010	-0.015,0.035
Reconstituted	-0.019	-0.039,0.001		0.0009	-0.002,0.021
Other	0.043	-0.010,0.098		-0.028	-0.052,-0.004*
HOUSING TENURE					
Private owned (reference)	•••	•••		•••	•••
Social rented	0.020	0.003,0.037*		-0.006	-0.0148,0.002
Private rented	0.006	-0.008,0.021		-0.004	-0.011,0.004
Other	0.022	-0.029,0.072		-0.002	-0.025,0.021
Don't know	0.012	0.001,0.023		-0.001	-0.008,0.006
OBSERVATIONS: 5412				**5633**	
CONSTANT: 0.748				**80.0**	

CHU-9D, and GLM modelling using adult valuation of CHU-9D

*Statistically significant - ** In this analysis, positive effect estimates indicate poorer health whereas negative

values indicate better health.

Appendix Table 3

Alternative specifications of the OLS model with either the GBS bullying victimization score or the ESYTC antisocial/aggressive behaviour score incorporated separately

	COEFFICIENT	BIAS CORRECTED 95% CI
GBS BULLYING VICTIMISATION SCALE		
Not bullied (reference)	•••	•••
bullied but not frequently & not upset	-0.039	-0.046,-0.033*
bullied either frequently or upset	-0.070	-0.077,-0.064*
bullied frequently and upset	-0.115	-0.127,-0.103*
ESYTC SCHOOL ANTISOCIAL/AGGRESSIVE BEHAVIOUR SCALE	-0.005	-0.006,-0.004*

*Statistically significant