Incidence of suicide, hospital-presenting non-fatal self-harm, and community-occurring non-fatal self-harm in adolescents in England (the iceberg model of self-harm): a retrospective study

Galit Geulayov, Deborah Casey, Keltie C McDonald, Pauline Foster, Kirsty Pritchard, Claudia Wells, Caroline Clements, Navneet Kapur, Jennifer Ness, Keith Waters, Keith Hawton

Summary

Background Little is known about the relative incidence of fatal and non-fatal self-harm in young people. We estimated the incidence of suicide, hospital-presenting non-fatal self-harm, and community-occurring non-fatal self-harm in adolescents in England.

Methods We used national mortality statistics (Jan 1, 2011, to Dec 31, 2013), hospital monitoring data for five hospitals derived from the Multicentre Study of Self-Harm in England (Jan 1, 2011, to Dec 31, 2013), and data from a schools survey (2015) to estimate the incidence of fatal and non-fatal self-harm per 100 000 person-years in adolescents aged 12–17 years in England. We described these incidences in terms of an iceberg model of self-harm.

Findings During 2011–13, 171 adolescents aged 12–17 years died by suicide in England (119 [70%] male and 133 [78%] aged 15–17 years) and 1320 adolescents presented to the study hospitals following non-fatal self-harm (1028 [78%] female and 977 [74%] aged 15–17 years). In 2015, 322 (6%) of 5506 adolescents surveyed reported self-harm in the past year in the community (250 [78%] female and 164 [51%] aged 15–17 years). In 12–14 year olds, for every boy who died by suicide, 109 attended hospital following self-harm and 3067 reported self-harm in the community, whereas for every girl who died by suicide, 1255 attended hospital for self-harm and 21 995 reported self-harm in the community. In 15–17 year olds, for every male suicide, 120 males presented to hospital with self-harm and 838 self-harmed in the community; whereas for every female suicide, 919 females presented to hospital for self-harm and 6406 self-harmed in the community. Hanging or asphyxiation was the most common method of suicide (125 [73%] of 171), self-poisoning was the main reason for presenting to hospital after self-harm (849 [71%] of 1195), and self-cutting was the main method of self-harm used in the community (286 [89%] of 322).

Interpretation Ratios of fatal to non-fatal rates of self-harm differed between males and females and between adolescents aged 12–14 years and 15–17 years, with a particularly large number of females reporting self-harm in the community. Our findings emphasise the need for well resourced community and hospital-based mental health services for adolescents, with greater investment in school-based prevention.

Funding UK Department of Health.

Lancet Psychiatry 2018
5: 167–74

Published Online
December 12, 2017
http://dx.doi.org/10.1016/S2215-0366(17)30478-9

See Comment page 100

Centre for Suicide Research, Department of Psychiatry, University of Oxford, Warneford Hospital, Oxford, UK (G Geulayov PhD, D Casey BSc, K C McDonald MSc, Prof K Hawton FMedSci); **Foster and Brown Research, Cirencester, UK** (P Foster MPhil); **Gloucestershire County Council, Gloucester, UK** (K Pritchard PGCE); **Office for National Statistics, UK** (C Wells MMath); **Centre for Suicide Prevention, Manchester Academic Health Sciences Centre, University of Manchester, Manchester, UK** (C Clements MRes, Prof N Kapur FRCPsych); **Greater Manchester Mental Health NHS Foundation Trust, Manchester, UK** (Prof N Kapur); **and Centre for Self-harm and Suicide Prevention Research, Derbyshire Healthcare NHS Foundation Trust, Derby, UK** (J Ness MSc, K Waters RMN)

Correspondence to:
Prof Keith Hawton, Centre for Suicide Research, Department of Psychiatry, University of Oxford, Warneford Hospital, Oxford OX37JX, UK
keith.hawton@psych.ox.ac.uk

Introduction

Suicide and non-fatal self-harm in adolescents are major public health concerns. Self-harm is common in adolescents, particularly in females and from the age of 12 years onwards,[1,2] and suicide is a leading cause of death in this age group.[3] Furthermore, self-harm is the strongest risk factor for suicide in children and adolescents.[1]

One report suggests that in 2014–15, 316 people aged 10–19 years died by suicide in England and Wales.[4] Few data are available on the incidence of non-fatal hospital-presenting self-harm in England, especially in adolescents. However, reports from the Multicentre Study of Self-harm in England (2000–07) showed that the annual incidence of hospital-presenting self-harm was 67 per 100 000 in boys and 466 per 100 000 in girls aged 10–14 years, and 302 per 100 000 in males and 1423 per 100 000 in females aged 15–18 years.[5,6] Data on non-fatal self-harm in adolescents in the community are also scarce. Previous studies, including two school-based surveys and a birth cohort in England including 13–18-year-old adolescents, showed that 6·9–11·0% of respondents had reported an act of self-harm in the year before the study.[7–9]

The incidence of self-harm in adolescents can be conceptualised in terms of an iceberg model[10,11] with three levels: fatal self-harm (ie, suicide), which is an overt but uncommon behaviour (the tip of the iceberg); self-harm that results in presentation to clinical services, especially general hospitals, which is also overt, but common; and self-harm that occurs in the community, which is common but largely hidden (the submerged part of the iceberg). The iceberg model is useful for clinicians, researchers, and policy makers because it

Research in context

Evidence before this study

In adolescents, non-fatal self-harm is a common reason for hospital presentation and also occurs frequently in the community without coming to clinical attention. Suicide is a leading cause of death in adolescents and is often preceded by self-harm. However, little is known about the relative sizes of the populations of adolescents involved in these three levels of self-harm, despite the major implications such information could have for prevention and clinical management. We searched PubMed up to June 30, 2017, with the terms "suicide", "self-harm", "self-injury", "self-poisoning", "suicide attempt", "attempted suicide", "iceberg", "relative", "incidence", "rates", "adolescents", "adolescence", and "young". We did not apply any language restrictions. Although several studies have addressed the incidence of each type of self-harm (suicide, hospital-presenting self-harm, and community-occurring self-harm), to our knowledge only one study has addressed the relative incidence of all three forms of self-harm. In a study published in 2014, McMahon and colleagues estimated the relative incidence of fatal and non-fatal self-harm in older adolescents (15–17 years) in Ireland and described these in terms of the three levels of an iceberg model. Their study showed that for every adolescent who died by suicide, 34 adolescents presented to the hospital for non-fatal self-harm and 555 adolescents reported self-harm in the community. The differences between incidences of fatal and non-fatal self-harm were particularly marked in females.

Added value of this study

We used national data on suicide, together with data on hospital-presenting self-harm from five hospitals from three research centres and data on self-harm in the community from a large-scale schools survey to calculate the relative incidence of fatal and non-fatal self-harm in adolescents aged 12–17 years in England. Estimated rates of fatal and non-fatal self-harm show that for every adolescent suicide, there are approximately 370 adolescents who present to hospital for self-harm and 3900 adolescents who report self-harm in the community. Consistent with previous research, our results show substantially higher incidences of both hospital-presenting and community-occurring non-fatal self-harm (which mostly does not come to the attention of clinical services) in females than in males. Our findings also show substantial differences in methods of self-harm between the three levels of the iceberg model, with hanging or asphyxiation the most common method of suicide, self-poisoning the main method used in hospital-presenting self-harm, and self-cutting the most common method of self-harm in the community.

Implications of all the available evidence

Taken together, our results and previous findings show the extent of fatal and non-fatal self-harm in adolescents, highlighting the sizeable problem of community-occurring self-harm, especially in females, but also that most self-harm, especially in young adolescents, does not come to the attention of clinical services. These data emphasise the need for preventive measures at the community level, especially through school-based programmes, and for well developed treatment services to meet the needs of those presenting to clinical services following self-harm.

conveys the hierarchical yet dynamic nature of self-harm. Establishing the relative incidence of self-harm at these three levels is important to understand the extent of the problem and to identify the challenges for prevention and intervention.

The overall aim of this study was to describe the extent of fatal and non-fatal self-harm in adolescents in England in terms of the three levels of the iceberg model, together with the methods of self-harm predominantly used at each level of the iceberg.

Methods

Study design and population

For this retrospective analysis, we analysed mortality statistics, hospital monitoring data, and schools survey data for adolescents aged 12–17 years in England. Information about deaths by suicide in England was obtained from the Office for National Statistics (ONS) by year of registration, single year of age, and sex. All deaths with a coroner's verdict of suicide (ICD-10 codes X60–X84) or undetermined intent (ICD-10 codes Y10–Y34) registered between Jan 1, 2011, and Dec 31, 2013, were included. These deaths are henceforth referred to as suicides, as per national policy.[12–14] Mid-year population estimates for England were provided by ONS by sex, calendar year, and single year of age.[15]

Data on hospital-presenting self-harm were derived from the Multicentre Study of Self-Harm in England; in this ongoing study, data are collected on all presentations following self-harm to the emergency department in five general hospitals in Manchester (three hospitals), Derby (one hospital), and Oxford (one hospital).[16,17] Demographic and clinical data, including method of self-harm, are collected through completion of psychosocial assessments by liaison psychiatry services in the general hospital (also by emergency department staff in Manchester). People who present to hospital but do not receive a psychosocial assessment are identified through scrutiny of emergency department electronic databases by trained staff, who extract less complete data from case records.

Self-harm is defined as any act of intentional self-poisoning or self-injury irrespective of the degree of suicidal intent or other motivation.[18] In this analysis, we included the first presentation by each individual per year between Jan 1, 2011, and Dec 31, 2013. We included adolescents who resided in the catchment area of the city of Manchester, Derby unitary area, or Oxford extended area (Oxford city and an additional 64 statistical wards

For more on **methods and data quality of ONS mid-year population estimates** see https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/qmis/annualmidyearpopulationestimatesqmi

from which at least 90% of emergency hospital admissions are to the general hospital in Oxford). Mid-year population estimates for England were obtained from ONS by sex, calendar year, single year of age, and local authority.[15]

Information about self-harm in the community was obtained from a web-based survey done within the county of Gloucestershire as part of the Emotional Health and Well-Being Survey, 2015.[19] All secondary state schools and other educational settings including sixth forms (ages 16–18 years), free schools, special schools (for pupils with special educational needs), alternative learning centres (pupil referral units), and senior independent schools in Gloucestershire were invited to take part (43 schools) and 29 schools (67%) opted in. All pupils in year 8 (aged 12–13 years), year 10 (aged 14–15 years), and year 12 (aged 16–17 years) in participating schools were invited to complete the survey. Of 5584 pupils eligible to participate in the survey, 5520 were in the required age range for our study (12–17 years), of whom 2814 (51%) were female and 2706 (49%) were male.

The survey consisted of a detailed questionnaire about self-harm (see appendix). Pupils who reported self-harm in the past year (items 1b and 1d) had their free-text (item 1e) descriptions of the methods of self-harm (if they gave a response) independently reviewed by two researchers (GG and KCM) to determine whether they met the study criteria,[9] as developed for the Child and Adolescent Self-harm in Europe study.[20] The criteria are available on request. Differences in classification were reconciled through discussion with a senior investigator (KH).

The proportion of pupils eligible for free school meals was used as a proxy measure of deprivation and compared with national figures to assess the extent to which the sample was representative of 12–17 year olds in England.

Finally, we obtained information on lifetime prevalence of self-harm in the school survey in 2014, which was the closest year available to 2011–13, on which we based our calculation of incidence of suicide and hospital-presenting non-fatal self-harm, and compared it with the figure from the 2015 survey to assess stability of the findings.

Approval from ONS was obtained in the format of a microdata agreement. ONS provided anonymised data at the individual level. For the Multicentre Study of Self-harm in England, the monitoring systems in Oxford and Derby have received approval from national health research ethics committees to collect data on self-harm. Self-harm monitoring in Manchester is part of a local clinical audit system ratified by the local research ethics committee. All three monitoring systems are fully compliant with the Data Protection Act (1998) and have approval under Section 251 of the National Health Service (NHS) Act (2006) to collect patient-identifiable information without patient consent. The leaders of the Emotional Health and Well-Being Survey (PF and KP) obtained approval for the survey from participating schools. Pupils were able to opt out. Data for the study were obtained in an anonymised format. No further ethical approval was sought for use of the school-based survey data for this analysis following advice from the University of Oxford's clinical trials and research governance team that use of anonymised secondary data not originating in the NHS does not require ethical approval.[21]

Data analysis

We calculated the incidence of suicide, hospital-presenting non-fatal self-harm, and community-occurring non-fatal self-harm per 100 000 person-years using Poisson distribution with exact 95% CIs. Analyses were run by sex and age group (12–14 years and 15–17 years). We used Poisson regression models to compare rates of self-harm between males and females and between adolescents aged 12–14 years and 15–17 years. Negative binomial regression models were used if there was evidence of over-dispersion as indicated by the Pearson goodness-of-fit test.

Rates of death by suicide were calculated from the number of deaths by suicide and mid-year population estimates for the equivalent period in England. Rates of hospital-presenting self-harm were calculated from the number of individuals presenting to the participating

See Online for appendix

	Number	Person-years	Incidence per 100 000 person-years (95% CI)
Suicide (2011–13)			
Males			
12–14 years	26	2 842 872	0·92 (0·60–1·34)
15–17 years	93	2 990 610	3·11 (2·51–3·81)
Females			
12–14 years	12	2 709 592	0·44 (0·23–0·77)
15–17 years	40	2 830 359	1·41 (1·01–1·92)
All (12–17 years)	171	11 373 433	1·50 (1·29–1·75)
Hospital-presenting non-fatal self-harm (2011–13)			
Males			
12–14 years	59	60 362	97·74 (74·41–126·08)
15–17 years	233	62 787	371·10 (324·97–421·93)
Females			
12–14 years	284	56 623	501·56 (444·92–563·42)
15–17 years	744	57 793	1287·35 (1196·50–1383·28)
All (12–17 years)	1320	237 565	555·64 (526·06–586·44)
Community-occurring non-fatal self-harm (2015)			
Males			
12–14 years	35	1268	2760·25 (1922·62–3838·84)
15–17 years	37	1424	2598·31 (1829·45–3581·43)
Females			
12–14 years	123	1398	8798·28 (7312·23–10 497·60)
15–17 years	127	1416	8968·93 (7476·99–10 671·32)
All (12–17 years)	322	5506	5848·17 (5226·77–6523·11)

Table: **Deaths by suicide (2011–13), hospital-presenting non-fatal self-harm (2011–13), and community-occurring non-fatal self-harm (2015), by sex and age group**

hospitals who resided in the defined catchment areas and the mid-year population estimates for these areas. For each individual we used the first presentation to hospital for self-harm within each year (2011, 2012, and 2013). Rates of community-occurring self-harm were calculated from the number of pupils reporting self-harm in the past year (with a valid method described) and the population of pupils who participated in the survey.

We calculated the proportion of individuals using different methods of self-harm: self-poisoning, self-injury (cutting or stabbing, hanging or asphyxiation, and all other self-injury methods), within the different levels of the iceberg model. We also assessed the overlap between hospital-presenting and community-occurring self-harm and characterised these individuals in terms of sex, age, and self-harm method. We did all analyses with Stata version 14.1.

Role of the funding source

The Multicentre Study of Self-harm in England is funded by the UK Department of Health, which had no role in study design, data collection, data analysis, data interpretation, or writing of the report. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

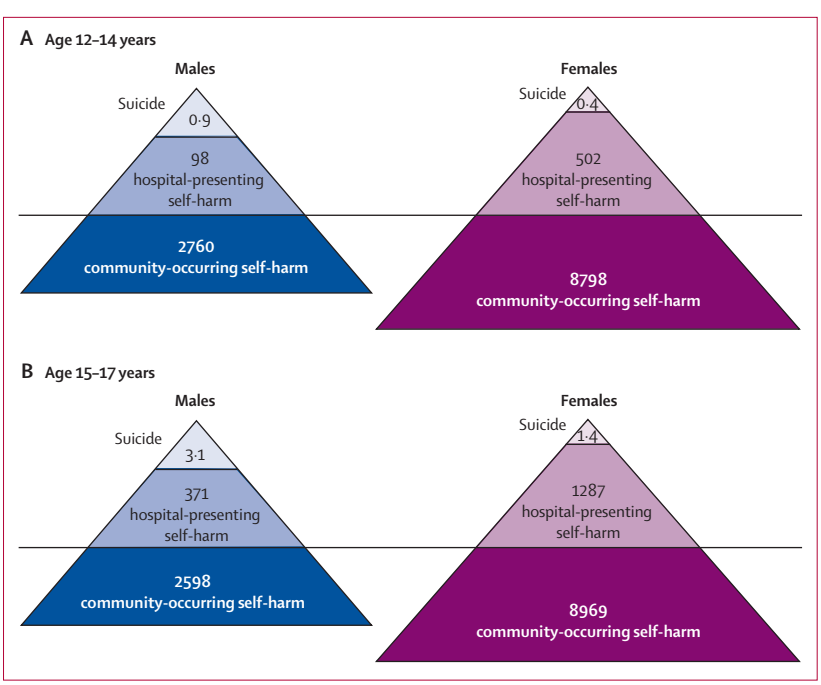

Figure 1: **Incidence of fatal and non-fatal self-harm per 100 000 person-years by age group and sex**
(A) Age 12–14 years. Rate ratio of suicide to hospital self-harm and to community self-harm: 1:109:3067 for males and 1:1255:21 995 for females. Rate ratio of hospital self-harm to community self-harm: 1:28 for males and 1:18 for females. (B) Age 15–17 years. Rate ratio of suicide to hospital self-harm to community self-harm: 1:120:838 for males and 1:919:6406 for females. Rate ratio of hospital self-harm to community self-harm: 1:7 for males and 1:7 for females. The horizontal line represents the division between overt behaviour (suicide and hospital-presenting self-harm) and covert behaviour (non-fatal self-harm occurring in the community, which often does not come to the attention of clinical services).

Results

During 2011–13, there were 171 registered suicides in adolescents aged 12–17 years in England: 119 in males and 52 in females (ie, 57 suicides per year: 40 in males and 17 in females; table). During the same period, 1320 adolescents aged 12–17 years (292 males and 1028 females) presented to the five general hospitals in the Multicentre Study of Self-harm in England following self-harm (ie, 440 adolescents per year: 97 males and 343 females).

Of the 5520 pupils aged 12–17 years who entered the schools survey in 2015, 14 were excluded because their sex was not recorded, resulting in 5506 eligible adolescents. Overall, 660 (12%) of 5506 pupils reported self-harm in the year before the survey, of whom 433 (66%) provided a description of the method used. Data for 322 (6%) of 5506 pupils who described a method of self-harm that met the study criteria were used in the analyses (250 females and 72 males).

Figure 1 shows the incidence of suicides, hospital-presenting self-harm, and community-occurring self-harm according to the different compartments of the iceberg model. The incidence of suicide in adolescents aged 12–17 years was 1·5 per 100 000 person-years, and the incidences of hospital-presenting and community-occurring self-harm were 556 per 100 000 person-years and 5848 per 100 000 person-years, respectively (table). In adolescents aged 12–14 years, the incidence of suicide in boys was more than double that in girls (incidence rate ratio [IRR] 2·07, 95% CI 1·04–4·09, p=0·038), and the incidence of non-fatal self-harm was substantially greater in girls than in boys (hospital-presenting self-harm: IRR 5·12, 2·51–10·42, p<0·0001; community-occurring self-harm: IRR 3·19, 2·19–4·64, p<0·0001).

In adolescents aged 15–17 years, the incidence of suicide in males was more than twice that in females (IRR 2·20, 95% CI 1·28–3·79, p=0·004). The incidence of non-fatal self-harm was more than three times greater in females than in males (hospital-presenting self-harm: IRR 3·47, 2·99–4·02, p<0·0001; community-occurring self-harm: IRR 3·45, 2·39–4·99, p<0·0001). The incidence of community-occurring self-harm in adolescents aged 15–17 years was similar to that in those aged 12–14 years in both males and females (males: IRR 0·94, 0·59–1·49, p=0·80; females: IRR 1·02, 0·80–1·31, p=0·88), whereas the incidence of suicide was more than three times higher in adolescents aged 15–17 years than in those aged 12–14 years in both males (IRR 3·40, 1·85–6·23, p<0·0001) and females (IRR 3·19, 1·67–6·08, p<0·0001). However, incidence of hospital-presenting non-fatal self-harm was more than two times higher in females aged 15–17 years than in females aged 12–14 years (IRR 2·57, 2·24–2·94, p<0·0001) and nearly four times greater in males aged 15–17 years than in males aged 12–14 years (IRR 3·80, 2·46–5·86, p<0·0001).

On the basis of the estimated incidences of fatal and non-fatal self-harm, in adolescents aged 12–14 years, for

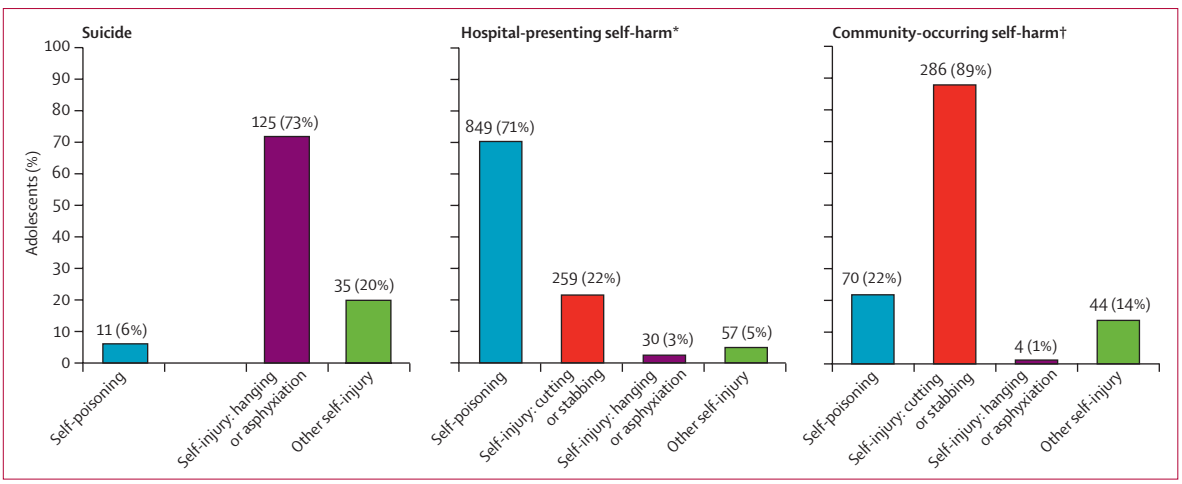

Figure 2: **Methods of suicide, hospital-presenting non-fatal self-harm, and community-occurring non-fatal self-harm**
Data are n (%). Percentages are the proportion of the total number of individuals within each self-harm group (suicide, n=171; hospital-presenting self-harm, n=1195; community-occurring non-fatal self-harm, n=322). *Does not include adolescents who used both self-poisoning and self-injury. The data refer to each individual's first episode of hospital-presenting self-harm during 2011–13. †Can include more than one method per person.

every boy who died by suicide, approximately 100 presented to hospital following self-harm and 3000 reported self-harm in the community. For every girl who died by suicide, approximately 1200 presented to hospital following self-harm and 22 000 reported self-harm in the community (figure 1).

In adolescents aged 15–17 years, for every male suicide, about 120 males presented to the hospital following self-harm and around 800 reported self-harm in the community, whereas in females, for every suicide, approximately 900 presented to hospital with self-harm and 6400 self-harmed in the community.

The most common method of suicide was hanging or asphyxiation (figure 2). Most adolescents presenting to hospital following self-harm did so after self-poisoning. A substantial proportion also presented after self-cutting. Most pupils who reported self-harm in the community had used self-cutting.

28 (9%) of the 322 participants of the schools survey who reported self-harm in the year before the survey presented to hospital for self-harm; six (4%) of 158 pupils aged 12–14 years and 22 (13%) of 164 pupils aged 15–17 years. Most adolescents presenting to hospital were female (n=27 [96%]), aged 15–17 years (n=22 [79%]), and had self-poisoned (n=22 [79%]).

To take account of this overlap between community-occurring and hospital-presenting self-harm, we also calculated the incidence of self-harm in pupils who had not presented to hospital as a result of their self-harm (n=294). In 12–14 year olds, the incidence was 2760 per 100 000 person-years in males and 8369 per 100 000 person-years in females; in 15–17 year olds, the incidence was 2528 per 100 000 person-years in males and 7486 per 100 000 person-years in females.

Information provided by 26 of the 29 participating schools indicated that 612 (8%) of 7620 pupils in years 8 and 10 were eligible for free school meals in 2015 (free school meals are not available in year 12) compared with 14% of pupils in state-funded secondary schools in England in 2015.[22]

With regard to lifetime prevalence of self-harm, we found that 985 (18·1%) of 5428 pupils who entered the 2014 survey reported having ever self-harmed compared with 2388 (18·2%) of 13 090 in the 2015 survey, indicating that the proportions of lifetime self-harm in the school surveys were stable.

Discussion

We estimated the relative incidences of fatal and non-fatal self-harm in adolescents in England and described these in terms of the three levels of the iceberg model of self-harm.[10,11] Our results highlight differences in the ratios of fatal to non-fatal self-harm in males and females, with higher incidence of suicide in males than in females and higher incidence of self-harm in females than in males. The incidence of hospital-presenting non-fatal self-harm differed greatly between younger and older adolescents, but the incidence of self-harm in the community did not differ substantially between the two age groups in either males or females. Substantial differences in methods of self-harm were evident at different levels of the iceberg model, with hanging or asphyxiation the most common method of suicide, self-poisoning the most frequent method of self-harm in adolescents presenting to hospital, and self-cutting the main method of self-harm in the community.

Extrapolation from the estimated incidences of fatal and non-fatal self-harm in our study to the population of England suggests that every year, about 21 000 adolescents aged 12–17 years present to hospital following self-harm and 200 000 self-harm in the community and do not present to hospital. The latter estimation does not take

account of pupils who reported self-harm in the community and also presented to hospital for self-harm. However, this number could also be a considerable underestimate.

In a study of adolescents aged 15–17 years in Ireland, McMahon and colleagues[11] reported that the annual incidence of suicide was 16·5 per 100 000 in males and 2·7 per 100 000 in females, a male-to-female ratio of 6:1, compared with the ratio of 2:1 in our study. However, the investigators reported lower rates of hospital-presenting self-harm than seen in our study. The difference is especially notable for females, with a three-times higher incidence of hospital-presenting self-harm in our study than in the Irish study (1287·35 [95% CI 1196·50–1383·28] *vs* 438·1 [320·30–555·96] per 100 000 person-years). As noted by McMahon and colleagues, the Multicentre Study of Self-harm in England is focused primarily on urban populations, in which self-harm rates are known to be somewhat higher than in rural areas,[23] whereas the Irish study was based on predominantly rural populations.[11] Differences between rural and urban populations in terms of access to hospitals, which is more limited in rural settings, might also have contributed to the difference in incidence. Furthermore, in Ireland most people attending emergency departments (including young people) are charged for their visit, which could discourage attendance. Nevertheless, community incidence rates of self-harm in the Irish study were remarkably similar to those in our study. Notably, a large study of 15–16-year-old pupils in schools in Oxfordshire, Northamptonshire, and Birmingham during 2000–01 identified somewhat higher community rates than in our study, of 3184 per 100 000 per year in males and 11 062 per 100 000 in females,[9] possibly because the focus of that study was on schools in urban areas and differences in socioeconomic deprivation[24] between the study areas. Furthermore, in our study, 9% of pupils presented to hospital following an episode of self-harm, compared with 6% in the Irish study[11] and 13% in the earlier survey in England.[9]

Our study has some limitations. Despite the inclusion of the ICD-10 codes of death due to undetermined intent, there might have been substantial under-identification of suicides by coroners, especially for deaths involving self-poisoning, where potential suicides are often assigned a verdict of accidental death.[25,26] Also, pupils in the schools survey might have under-reported self-harm because of embarrassment and stigma that might be associated with mental health problems, although the survey was completed anonymously. Furthermore, in the schools survey we only included individuals who described a method of self-harm meeting our criteria, so our estimates of incidence of community-occurring self-harm in the past year are conservative. Nevertheless, the findings from this study are in keeping with findings from earlier studies, including a survey in England[9] and a study in Ireland,[27] all of which used similar methods (self-harm in the past year: 6%, 6·9%, and 5·7%, respectively).

The estimated incidences of hospital-based and community-occurring non-fatal self-harm should be treated with caution because they were based on data from specific geographical areas. Information about hospital-presenting self-harm was based on data from three research centres comprising five hospitals and might not be representative of England as a whole, although these centres have socioeconomically diverse populations. The sample used to estimate the community level of self-harm might have been of higher socioeconomic status than the general population of adolescents in England; socioeconomic position is inversely associated with self-harm.[24] The proportion of pupils eligible for free school meals (8%) was lower in the schools survey than the equivalent proportion in England (14%). Furthermore, on the basis of the Index of Multiple Deprivation, the county of Gloucestershire is of average or above average socioeconomic position relative to the rest of the country. Our estimated school-based incidences of self-harm might therefore underestimate the true incidence of non-fatal self-harm in the community, although findings from other similar studies[9,11] are consistent with our results. Furthermore, most school pupils who reported self-harm in the past year and presented to hospital used self-poisoning (79%), a proportion consistent with that from the Multicentre Study of Self-harm in England (71%). Finally, estimates of community-occurring self-harm were based on data from 2015, whereas estimates of suicides and hospital-presenting self-harm were based on data from 2011 to 2013.

Our findings highlight the population burden of fatal and non-fatal self-harm in adolescents and underline the need for preventive and therapeutic measures at different levels of the iceberg model. Suicide is fairly rare in adolescents but is always a possibility, especially in those who self-harm.[1] It has devastating effects on family,[28,29] friends, fellow students and school staff, and communities. Our findings emphasise the need for effective suicide prevention initiatives for this age group and for appropriate and accessible support for those who are coping with the death of a young person by suicide.

The extent of hospital-presenting self-harm highlights the need for easily accessible community mental health services for young people and well resourced hospital-based services that can provide a comprehensive psychosocial assessment,[30] followed when appropriate by referral to further care, preferably including psychosocial treatment.[31,32] Self-harm in adolescents in the community is very common, especially in females. Several school-based programmes addressing prevention of self-harm in adolescence have been developed and assessed in recent years, including Saving and Empowering Young Lives in Europe,[33] and the Good Behaviour Game,[34,35] with some evidence of beneficial

effects. A further approach involves school-based screening,[36] although such interventions have not generally been adopted. Interventions might also be provided through online and mobile telephone applications, although currently there is little evidence of their effectiveness in adolescents.[37–39] Self-harm by adolescents often has a major impact on families, including stress, anxiety, and financial difficulties.[40,41] Therefore, family members themselves often need support.[41]

In conclusion, our findings support recent calls for improved community-based mental health services for young people,[42] along with well resourced hospital services and the implementation of evidence-based prevention programmes in schools.

Contributors

KH and GG were responsible for study conception and design, and interpretation of the results. GG and DC were responsible for data analysis and KCM made a substantial contribution to the analysis. KH, NK, KW, DC, CC, JN, PF, KP, and CW acquired the data. GG drafted the report, which all authors critically revised for intellectual content. All authors approved the final report and are accountable for all aspects of this work. KH supervised the study and is the guarantor.

Declaration of interests

KH and NK declare grants from the National Institute for Health Research. NK also declares funding from the Health Quality Improvement Partnership and that he chairs the National Institute of Health and Care Excellence (NICE) self-harm and NICE depression groups. All other authors declare no competing interests.

Acknowledgments

The Multicentre Study of Self-harm in England is funded by the UK Department of Health. KH is a National Institute for Health Research (NIHR) Senior Investigator. The views expressed are those of the authors and not necessarily those of the NHS, the NIHR, or the Department of Health. We thank Fiona Brand and Liz Bale in Oxford for their assistance with data collection and Muzamal Rehman (Derbyshire Healthcare Foundation Trust, Derby, UK) for data processing. We also thank Jane Holmes (University of Oxford, Oxford, UK) and Paul Corcoran (University College Cork, Cork, Ireland) for providing statistical advice.

References

1 Hawton K, Bergen H, Kapur N, et al. Repetition of self-harm and suicide following self-harm in children and adolescents: findings from the Multicentre Study of Self-harm in England. *J Child Psychol Psychiatry* 2012; **53:** 1212–19.

2 Hawton K, Harriss L. How often does deliberate self-harm occur relative to each suicide? A study of variations by gender and age. *Suicide Life Threat Behav* 2008; **38:** 650–60.

3 Office for National Statistics. Top 5 leading causes of death by sex and five-year age group, England and Wales: 2014 registrations. April, 2016. https://www.ons.gov.uk/peoplepopulationand community/birthsdeathsandmarriages/deaths/adhocs/005656top5leadingcausesofdeathbysexandfiveyear agegroupenglandandwales2014registrations (accessed Oct 31, 2017).

4 National Confidential Inquiry into Suicide and Homicide by People with Mental Illness (NCISH). Suicide by children and young people. Annual report: England, Northern Ireland, Scotland and Wales. July, 2017. http://research.bmh.manchester.ac.uk/cmhs/research/centreforsuicideprevention/nci (accessed Aug 29, 2017).

5 Hawton K, Bergen H, Waters K, et al. Epidemiology and nature of self-harm in children and adolescents: findings from the Multicentre Study of Self-harm in England. *Eur Child Adolesc Psychiatry* 2012; **21:** 369–77.

6 Clements C, Turnbull P, Hawton K, et al. Rates of self-harm presenting to general hospitals: a comparison of data from the Multicentre Study of Self-Harm in England and Hospital Episode Statistics. *BMJ Open* 2016; **6:** e009749.

7 Kidger J, Heron J, Lewis G, Evans J, Gunnell D. Adolescent self-harm and suicidal thoughts in the ALSPAC cohort: a self-report survey in England. *BMC Psychiatry* 2012; **12:** 69.

8 Morey Y, Mellon D, Dailami N, Verne J, Tapp A. Adolescent self-harm in the community: an update on prevalence using a self-report survey of adolescents aged 13-18 in England. *J Public Health (Oxf)* 2017; **39:** 58–64.

9 Hawton K, Rodham K, Evans E, Weatherall R. Deliberate self-harm in adolescents: self report survey in schools in England. *BMJ* 2002; **325:** 1207–11.

10 Hawton K, Saunders KEA, O'Connor RC. Self-harm and suicide in adolescents. *Lancet* 2012; **379:** 2373–82.

11 McMahon EM, Keeley H, Cannon M, et al. The iceberg of suicide and self-harm in Irish adolescents: a population-based study. *Soc Psychiatry Psychiatr Epidemiol* 2014; **49:** 1929–35.

12 Linsley KR, Schapira K, Kelly TP. Open verdict v. suicide—importance to research. *Br J Psychiatry* 2001; **178:** 465–68.

13 Gunnell D, Bennewith O, Simkin S, et al. Time trends in coroners' use of different verdicts for possible suicides and their impact on officially reported incidence of suicide in England: 1990–2005. *Psychol Med* 2013; **43:** 1415–22.

14 Office for National Statistics. Statistical update on suicide. February, 2015. https://www.gov.uk/government/uploads/system/uploads/attachment_data/fi,le/405411/Statistical_update_on_suicide_acc.pdf (accessed Oct 31, 2017).

15 Office for National Statistics. Population estimates for UK, England and Wales, Scotland and Northern Ireland. Mid-2016. https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/populationestimatesforukenglandandwalesscotlandandnorthernireland (accessed Oct 31, 2017).

16 Geulayov G, Kapur N, Turnbull P, et al. Epidemiology and trends in non-fatal self-harm in three centres in England, 2000–2012: findings from the Multicentre Study of Self-harm in England. *BMJ Open* 2016; **6:** e010538.

17 Hawton K, Bergen H, Casey D, et al. Self-harm in England: a tale of three cities. Multicentre study of self-harm. *Soc Psychiatry Psychiatr Epidemiol* 2007; **42:** 513–21.

18 Hawton K, Hall S, Simkin S, et al. Deliberate self-harm in adolescents: a study of characteristics and trends in Oxford, 1990-2000. *J Child Psychol Psychiatry* 2003; **44:** 1191–98.

19 Gloucestershire County Council. Emotional Health and Well-being Gloucestershire Online Pupil Survey. Online Pupil Survey (OPS) Program. 2015. http://www.fabresearch.com/schoolsurveys.htm (accessed Dec 1, 2017).

20 Madge N, Hewitt A, Hawton K, et al. Deliberate self-harm within an international community sample of young people: comparative findings from the Child & Adolescent Self-harm in Europe (CASE) Study. *J Child Psychol Psychiatry* 2008; **49:** 667–77.

21 University of Oxford Clinical Trials and Research Governance team. Decision flowchart for CUREC. August, 2016. https://www.admin.ox.ac.uk/media/global/wwwadminoxacuk/localsites/curec/documents/Decision_flowchart_for_CUREC.pdf (accessed Dec 1, 2017).

22 Office for National Statistics. Schools, pupils and their characteristics: January, 2015. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/433680/SFR16_2015_Main_Text.pdf (accessed Oct 31, 2017).

23 Harriss L, Hawton K. Deliberate self-harm in rural and urban regions: a comparative study of prevalence and patient characteristics. *Soc Sci Med* 2011; **73:** 274–81.

24 Hawton K, Harriss L, Hodder K, Simkin S, Gunnell D. The influence of the economic and social environment on deliberate self-harm and suicide: an ecological and person-based study. *Psychol Med* 2001; **31:** 827–36.

25 Gosney H, Hawton K. Inquest verdicts: youth suicides lost. *Psychiatr Bull* 2007; **31:** 203–05.

26 Palmer BS, Bennewith O, Simkin S, et al. Factors influencing coroners' verdicts: an analysis of verdicts given in 12 coroners' districts to researcher-defined suicides in England in 2005. *J Public Health (Oxf)* 2015; **37:** 157–65.

27 Morey C, Corcoran P, Arensman E, Perry IJ. The prevalence of self-reported deliberate self harm in Irish adolescents. *BMC Public Health* 2008; **8:** 79.

28 Bolton JM, Au W, Leslie WD, et al. Parents bereaved by offspring suicide: a population-based longitudinal case-control study. *JAMA Psychiatry* 2013; **70:** 158–67.

29 Pitman A, Osborn D, King M, Erlangsen A. Effects of suicide bereavement on mental health and suicide risk. *Lancet Psychiatry* 2014; **1:** 86–94.

30 National Institute for Health and Care Excellence (NICE). Self-harm in over 8s: short-term management and prevention of recurrence. Clinical guideline 16. London: National Institute for Health and Care Excellence, 2004. https://www.nice.org.uk/guidance/cg16 (accessed Oct 31, 2017).

31 Hawton K, Witt KG, Taylor Salisbury TL, et al. Interventions for self-harm in children and adolescents. *Cochrane Database Syst Rev* 2015; **12:** CD012013.

32 Hawton K, Witt KG, Salisbury TL, et al. Psychosocial interventions following self-harm in adults: a systematic review and meta-analysis. *Lancet Psychiatry* 2016; **3:** 740–50.

33 Wasserman D, Hoven CW, Wasserman C, et al. School-based suicide prevention programmes: the SEYLE cluster-randomised, controlled trial. *Lancet* 2015; **385:** 1536–44.

34 Katz C, Bolton SL, Katz LY, et al. A systematic review of school-based suicide prevention programs. *Depress Anxiety* 2013; **30:** 1030–45.

35 Wilcox HC, Kellam SG, Brown CH, et al. The impact of two universal randomized first- and second-grade classroom interventions on young adult suicide ideation and attempts. *Drug Alcohol Depend* 2008; **95** (suppl 1): S60–73.

36 Shaffer D, Scott M, Wilcox H, et al. The Columbia Suicide Screen: validity and reliability of a screen for youth suicide and depression. *J Am Acad Child Adolesc Psychiatry* 2004; **43:** 71–79.

37 Hill RM, Pettit JW. Pilot randomized controlled trial of LEAP: a selective preventive intervention to reduce adolescents' perceived burdensomeness. *J Clin Child Adolesc Psychol* 2016; published online Aug 17. DOI:10.1080/15374416.2016.1188705.

38 Robinson J, Hetrick S, Cox G, et al. Can an internet-based intervention reduce suicidal ideation, depression and hopelessness among secondary school students: results from a pilot study. *Early Interv Psychiatry* 2016; **10:** 28–35.

39 Van Voorhees BW, Fogel J, Reinecke MA, et al. Randomized clinical trial of an internet-based depression prevention program for adolescents (Project CATCH-IT) in primary care: 12-week outcomes. *J Dev Behav Pediatr* 2009; **30:** 23–37.

40 Hughes ND, Locock L, Simkin S, et al. Making sense of an unknown terrain: how parents understand self-harm in young people. *Qual Health Res* 2017; **27:** 215–25.

41 Ferrey AE, Hughes ND, Simkin S, et al. The impact of self-harm by young people on parents and families: a qualitative study. *BMJ Open* 2016; **6:** e009631.

42 Mental Health Taskforce to the NHS in England. Five year forward view for mental health. 2016. https://www.england.nhs.uk/wp-content/uploads/2016/02/Mental-Health-Taskforce-FYFV-final.pdf (accessed Oct 31, 2017).