Introduction

Worrying rates of childhood obesity and associated health problems have inspired health promotion interventions to increase physical activity amongst children and adolescents. Ideally such interventions would be evaluated by a randomized controlled trial, incorporating a valid measure of physical activity. Concerns about the reliability of self-report have encouraged investigators to look for more objective methods. Accelerometers may provide a practical, reliable and valid means of measuring the volume and intensity of physical activity in a study population. Accelerometers are increasingly used in health research to measure physical activity, but few published studies document participants’ views and experiences of wearing accelerometers, preferring to focus on measurement decisions and outcomes, and fewer still have reported the views and experiences of adolescent participants. The purpose of this study is to examine the use of accelerometers with young people including recruitment, retention and adherence to protocol. Methods: The AHEAD (Activity and Healthy Eating in Adolescence) feasibility study, involving over 1000 students aged 12/13 years, took place in south-west England between 2007 and 2009. Piloting work was followed by an exploratory trial, incorporating a process evaluation, in six schools. Students were asked to wear accelerometers for 7 days at baseline and follow-up. Results: Eighty-nine percent of students provided some accelerometer data at baseline and 87% at follow-up. However, adherence (recording ≥600 minutes per day for ≥3 days) fell from 75% at baseline to 56% at follow-up. Factors affecting adherence included the following: the use and type of incentives, appearance, discomfort and unforeseen changes to the school timetable. Conclusions: If worn properly, accelerometers can provide an important objective measure of physical activity in population-based studies promoting physical activity. But to achieve generalizable results, it is important to maximize recruitment, retention and adherence to protocol across the study population. For adolescents, adherence may be improved by the following: a ‘two-part’ reward (part one for returns, part two for adherence), personal activity graphs, and less obtrusive belts and monitors.
process of using accelerometers with over 1000 Year 8 students, aged 12 to 13 years, during the AHEAD (Activity and Healthy Eating in Adolescence) study. The focus is on the views of young people and lessons learned in relation to adherence.

**Methods**

**Study design**

The main aims of AHEAD were to test the feasibility of using an established peer-led health promotion model\(^{30,31}\) to encourage increased physical activity and healthy eating in adolescence, and to conduct an exploratory randomized controlled trial of the intervention.\(^{32}\) The study took place between October 2007 and December 2009 in the south-west of England. During Phase I, key components of the intervention and outcome evaluation were developed and piloted in one school. Phase II comprised an exploratory trial in six coeducational, comprehensive schools (three in each of the intervention and control arms), reflecting the context in which the majority of young people in England are educated. Written consent for the schools’ participation was obtained from head teachers. Letters were then posted by school staff to the parents/carers of all Year 8 students, explaining the study and enclosing a reply slip to return if they did not want their child to participate. This ‘opt-out’ method of parental permission has been found to be an ethical and appropriate way of informing parents/carers for low-risk prevention research and avoiding low response rates and potential sampling bias when active parental consent procedures are used.\(^{30,33}\) At baseline, students were informed that they could ‘opt-out’ of some or all of the study activities at any point and were asked to sign individual assent forms. The University of Bristol Faculty of Medicine and Dentistry Committee for Ethics gave ethical approval for the study.

**AHEAD intervention**

Influential Year 8 students were identified by their peers, using a peer nomination questionnaire and invited to become ‘peer supporters’, with the task of promoting increased physical activity and healthy eating amongst their peers. They received two-days training to equip them with the information, skills and confidence to undertake the role and were supported during four follow-up visits over the following ten weeks.

**AHEAD data collection**

Self-complete behavioural questionnaires and accelerometers were administered to all Year 8 students at baseline and follow-up. Observations, questionnaires and focus groups were undertaken to assess the feasibility and acceptability of implementing both the intervention and its evaluation.

**Accelometry**

Actigraph\textsuperscript{TM} GTM1 accelerometers costing approximately £200 (about $320) each were purchased with ActiLife Version 3.3.0 software and equipment to support their use. During Phase I, students were asked to wear accelerometers at baseline to test distribution and collection procedures, and the acceptability of the device to young people. Participating students were also given an Actigraph\textsuperscript{TM} GTM1 accelerometer from getting up in the morning until going to bed at night for seven days. Adherence was defined as recording for at least three days of at least ten hours per day. Data collectors gave a classroom demonstration and responded to students’ questions and concerns. In addition, brief written instructions included how and when the accelerometer should be worn and when it would be collected. Classroom staff were also informed when the researchers would return to collect the accelerometers. It was assumed, having explained the study aims and timetable, that school staff would encourage students to wear their accelerometers and return them on the due date. No specific incentives were initially given to students to wear or return their accelerometers.

To improve the rate and speed of returns during Phase II, it was agreed that a £10 (approximately $16) gift voucher would be given to all students who returned their accelerometer. The research team decided to test two further incentives: giving students information about the cost of accelerometers and providing a personal graph of physical activity. Students in only three of the schools were informed that the accelerometers cost £200 each but were not valuable without appropriate software. Similarly, it was planned that students in three schools would be given graphs of their activity.

**Data storage and analysis**

Data from the behavioural questionnaires were entered into a secure Access database. Accelerometer data were downloaded using ActiLife Version 3.3.0 software and stored as anonymised files. Quantitative analyses were conducted in Stata, version 11.0. Focus group recordings were fully transcribed, anonymized and stored in a secure folder. The transcripts were scrutinized for differences and similarities within emerging themes.

**Results**

**Recruitment and retention**

During Phase I, there were 99 students in Year 8, of whom 18 were absent at the accelerometer data collection and five refused to wear an accelerometer. During the Phase II trial, there were 928 Year 8 students across the six participating schools at baseline, 12 parents/carers returned the opt-out letter (although one changed their mind at follow-up), and one student refused to participate throughout the study. No students actively withdrew from the study, but 11 left participating schools before follow-up.

**Focus groups**

Nine focus groups were undertaken across the study, five during Phase I and four during Phase II, involving 61 students. All of the groups were mixed-sex, with participants randomly selected, and attendance ranged from three to nine students. Participation was voluntary and reasons for non-participation included absenteeism, preferring not to miss a lesson and involvement in other school activities.

During Phase I, 40 students (20 males, 20 females) were invited to participate in a focus group of whom 28 (15 males, 13 females) took part: 18 had worn and returned an accelerometer, four had lost an accelerometer and six had been absent when the accelerometers were distributed. During Phase II, focus groups took place in two schools: 40 students (20 males, 20 females) were invited; 17 males and 16 females took part, all of whom had worn and returned accelerometers. During focus group discussions, some students said they would have worn and returned the accelerometer without the offer of a gift voucher, although others suggested they would not have done so. In
practice, the prompt distribution of vouchers on receipt of accelerometers improved the returns process.

There were similar return rates whether or not the students were informed about the cost of accelerometers. However, qualitative evidence suggests some students preferred to have this information. For example, a male student commented: "Because then it’s like you know that it costs a lot, and also if you like keep it and sell it, it’s useless without the special computer to use it" (Focus group 6). A female student suggested: "Then they might give them back because like they can’t do anything with it, “cos they know how much they’re worth and if you break them it’s just going to be expensive" (Focus group 7).

Attempts to produce personal activity graphs for one school at the start of the exploratory trial proved extremely labour intensive and were subsequently abandoned. However, evidence from the Phase II focus groups suggests individual graphs would have been welcomed and may have increased adherence (box 1), despite some concerns that the public comparison of activity graphs might be upsetting or embarrassing for some young people.

**Phase II participation and adherence to protocol**

Response rates to the behavioural questionnaires were in excess of 90% throughout the exploratory trial. Accelerometers were worn and returned by 830 students (89%) at baseline and 805 (87%) at follow-up. At baseline 822 were successfully processed of which 620 (75%) met the inclusion criteria (table 1). There was a marked drop in adherence at follow-up, when 443 (56%) of 789 processed files met the inclusion criteria.

Questions about the accelerometers were included at the post-intervention data collection. Responses from students who completed questions about not wearing an accelerometer (n = 120), suggest that the main reason was absenteeism (56%), followed by worries about losing (28%) or breaking (25%) the accelerometer.

Similar questions were included for students who did wear accelerometers, and a large minority of respondents either agreed or strongly agreed with the statements: 'I was worried I would lose the accelerometer' (44%), and 'I was worried I would break the accelerometer' (41%). These concerns may have discouraged some students from wearing the accelerometer in specific circumstances. For example, data collectors noted students’ concerns about wearing the accelerometer during contact sports or when travelling abroad on a school trip.

During focus group discussions both genders suggested that the accelerometers were uncomfortable to wear, particularly in warmer weather or when being very active (box 2). These comments were supported by responses in the behavioural questionnaires where 40% of respondents agreed the accelerometers ‘got in the way’ (41%). These concerns may have discouraged some students from wearing the accelerometer in specific circumstances.

In terms of appearance, 61% of questionnaire respondents agreed or strongly agreed that ‘the accelerometers should have nicer belts’ and 36% either agreed or strongly agreed with ‘I didn’t like wearing the accelerometer with my best clothes’. During focus group discussions, girls expressed more concerns than boys about the appearance of the accelerometers (box 3). Nevertheless, girls were more likely to meet the inclusion criteria (table 1).

**Discussion**

The AHEAD feasibility study was unusual in examining the process of using accelerometers with adolescents in a relatively large-scale, population-based study. The positive recruitment and retention rates confirm the value of ‘opt-out’ parental permission plus student assent as the consent procedure. Requiring written parental consent may bias the sample by excluding adolescents from more disadvantaged or chaotic backgrounds.

**Box 1 Focus group extracts: personal activity graphs**

B99 (female): I only wore mine because I thought it would be good to see, it would be interesting to look at the results.
Researcher: OK. Right.

B96 (female): Do we get to see our results?
Researcher: Would you have liked your results?
All: Yeah.

B32 (female): No we wouldn’t, because I feel intimidated around other people.

(Focus group 6)

B44 (male): You can like mail it [graph] to an address instead of school. Because some, because if you like give it in to the school, I bet the teachers ask people to like hand it out. And some will like, volunteers like, would look through them. Like they’ll look through a graph and then like go, do random stuff with it, like tell people ‘Ugh on this day he does nothing’ and all that stuff.

(Focus group 7)

Researcher: Would you have liked graphs?
D12 (female): Yeah because that was what we got told. That when we did it, we’d have that.

D34 (female): And to see what, and see how much we’ve improved between the first time and the second time.

(Focus group 8)

D65 (female): I wanted to see how much activity I done from one though.

D85 (female): Can you, can you get your results back?
Researcher: Right, now this is another interesting question.
Would you have liked to have
D65 (female): I would have wore it more if D85: So that we can see like how we’ve changed as we’ve got more fitter.

(Focus group 9)

**Table 1 AHEAD exploratory trial: accelerometer adherence to protocol**

<table>
<thead>
<tr>
<th>Baseline data collection</th>
<th>Total</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students providing accelerometer data</td>
<td>822</td>
<td>423</td>
<td>399</td>
</tr>
<tr>
<td>Students providing ≥3 days, ≥500 minutes per day</td>
<td>620 (75.4%)</td>
<td>301 (71.2%)</td>
<td>319 (79.9%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Follow-up data collection</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Students providing accelerometer data</td>
<td>789</td>
<td>411</td>
<td>378</td>
</tr>
<tr>
<td>Students providing ≥3 days, ≥500 minutes per day</td>
<td>443 (55.9%)</td>
<td>214 (52.1%)</td>
<td>227 (60.1%)</td>
</tr>
</tbody>
</table>

At least 85% of participants provided some (but not always sufficient) accelerometer data at each data collection sweep. An important reason for not wearing an accelerometer was simply absenteeism on the day of distribution. It may have been possible to increase participation rates by returning the following week and distributing accelerometers for those absentees. But the study timetable, and limited equipment, required all available monitors to be prepared for use by the next school. For future studies, a larger pool of accelerometers may solve this problem, although it may not be desirable to include data from students wearing accelerometers a week later than the bulk of participants. Furthermore, financial considerations may restrict the number of accelerometers that can be purchased, and consequently the size and scope of individual studies. We agree with others that, given the abundance of inexpensive but relatively sophisticated electronic devices, it is difficult to understand why the cost of accelerometers remains relatively high.

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Box 2 Focus group extracts: accelerometers, discomfort and being active

B32 (female): I’m sorry to say but the belts are really uncomfortable.
B96 (female): They are, aren’t they!
(Focus group 6)
B156 (male): Sometimes I just thought no I don’t want to wear it, it’s uncomfortable.
(Focus group 7)
D12 (female): Yeah, don’t give them in the summer though ‘cos they’re really hot and we don’t like wearing them.
D59 (male): Uncomfortable.
D54 (female): Yeah give them in like autumn or spring.
D59 (male): Winter.
D12 (female): I know. They were hurting when we were playing football.

D76 (male): I took it off in PE.
D95 (male): Especially if you fall over.
D66 (male): I took it off for rugby and PE so I didn’t wear it as much.

D95 (male): Oh it hurts as well when you run around.
D12 (female): It rubs.

[over talking]
D12 (female): You get like rashes sometimes like heat rash on it.
D95 (male): Yeah and you get rashes ‘cos when it’s really hot it like rubs against you and if you take it off it’s like red mark.
D12 (female): Heat rash
(Focus group 8)

Box 3 Focus group extracts: the ‘look’ of the accelerometers

B32 (female): Sometimes it really does not work with your outfit. It doesn’t go.
B99 (female): Yeah it doesn’t look nice.
B144 (male): Hide it underneath.
B96 (female): You should get multi-coloured ones.
B32 (female): If you put it under your top it’s going to look like you’ve got a bigger side and that’s just wrong because if you put it over your top you still look like a geek [laughs]. Put it on your trousers you still look like something sticking out so we just don’t wear it with the
B99 (female): Yeah [laughs] big lump coming out. And you can see it.
B96 (female): At the weekends you just don’t wear it.
(Focus group 6)
B21 (female): I didn’t wear it on Saturday or Sunday . . . u you could see it with what I was wearing and, a bit embarrassing.
B156 (male): I think it’s because most boys don’t care about their clothes and girls just do.
B44 (male): Or fashion, because girls are always
B168 (female): ‘Oh I’ll wear this with that.’
(Focus group 7)
D12 (female): It liked cramped your style a bit because like when you put clothes on you had a fat lump.
(Focus group 8)
D7 (female): And it’s, they look really rubbish.
D18 (female): It just stuck up when I wore my top and it was really a mare.
D64 (male): Yeah I, I’m
D30 (male): A giant spot in the hip.
(Focus group 9)

Inclusive recruitment procedures may increase participation across the social spectrum but may also increase the proportion of accelerometers that are lost or damaged. The prompt reward of a £10 gift voucher increased the number and speed of returns when compared with the somewhat naïve approach adopted in the pilot school. Nevertheless, it is important to make a reasonable allowance for losses and damages in a study of this kind: in the case of AHEAD, approximately 11% for each data collection sweep.

Supplying information about the cost of accelerometers appeared to make no difference to return rates. This suggests the information did not prompt attempts to sell the monitors, or increase students’ reluctance to be responsible for a relatively expensive piece of equipment. Written and verbal information clarified that students would not be ‘in trouble’ if they lost or damaged their accelerometer. This message had to be balanced against requirements to keep within budget, obtain primary outcome data and swiftly recover accelerometers for the next data collection.

On balance, the study team felt young people should be informed of the cost to encourage a sense of responsibility and avoid equating accelerometers with much cheaper pedometers.

It was not possible to objectively assess whether giving individual graphs of activity influenced accelerometer returns because of the time and effort required to produce the graphs during a busy trial. However, young people expressed disappointment at not seeing their ‘results’. It may be that a tangible sign of their efforts at baseline would have encouraged more young people to wear and return their accelerometers at follow-up. Although the graphs may influence activity levels, it can be argued that the accelerometers already do this and any potential reactivity would occur in both intervention and control arms of a well-designed randomized controlled trial.

Future studies may wish to factor in additional hours for the production and distribution of activity graphs. However, care should be taken over the privacy of ‘results’ to avoid some students comparing graphs to embarrass others. It would be possible to send graphs to students’ homes, but this would create another task for schools (given the confidentiality of participants’ home addresses). In times of financial austerity, and bearing in mind the workload of school staff, these additional costs would have to be considered carefully. But if the aim is to encourage the participation of a broad range of young people, the benefits may outweigh the disadvantages. A swift method of giving some personal activity information to participants would seem desirable.

Although researchers had some control over distribution and collection procedures, they had less influence over adherence. In studies involving fewer participants (often involving consenting adults and involving specific health problems), it may be possible to incorporate regular contact with the research team to encourage adherence to protocol. But such close contact is less feasible in a large-scale trial.

The school context, and particular timetabling issues, played a part in reducing adherence at follow-up. At the beginning of the exploratory trial, a member of the research team visited each school to explain the study in detail, including the importance of continuing with the normal curriculum in all other respects, and to agree a timetable. However, as the study progressed, one school arranged a holiday in France for the week when students were asked to wear accelerometers; and the data collection in another (control) school coincided with a special physical activity week. In both cases, it was impossible to reschedule. This was a powerful reminder that no matter how well a study is explained at the beginning, it is important to regularly impress upon school staff that data collections should not be scheduled during weeks when there are special...
activities, and to highlight the difficulties of changing a research timetable involving multiple locations.

The AHEAD timetable involved baseline data collection in the autumn and follow-up in the summer. Although the timetable may have been acceptable in a feasibility study, with the emphasis on developing and testing methods, concerns about wearing the accelerometers on an elastic belt around the waist in warm weather appear to have affected adherence at follow-up. This would suggest a less obtrusive device or belt would be advantageous.

Girls appeared more concerned than boys about the ‘look’ of the accelerometers, especially when they were out of school uniform and wearing more fashionable clothes. Consequently, the black elastic belt, together with the requirement to wear the accelerometer around the waist, may undermine the measurement of adolescent physical activity particularly at weekends. Furthermore, removing the accelerometer for some sports has clear implications for measuring moderate to vigorous physical activity. Boys in particular indicated they did not wear accelerometers when they were at their most active. Their reasons included discomfort, fear of breaking it and fear of the monitor hurting themselves or others during contact sports. Reassuring students and staff about the robustness of accelerometers may help, but would not overcome issues of physical discomfort.

Finally, some young people were aware that they would receive the £10 gift voucher for ‘returning’, rather than ‘wearing’, the accelerometer. This may also have affected adherence. An obvious solution would be to award the gift voucher only if the inclusion criteria are met. This would slow down the returns process, as data would have to be downloaded and checked before vouchers could be distributed. Furthermore, it may increase losses since participants who realize they have not met the inclusion criteria would have less incentive to return the accelerometer at all. A compromise, such as giving a £5 voucher when an accelerometer is returned and an additional £5 voucher if the inclusion criteria are met, may be the solution.

If worn properly, accelerometers can provide an important objective measure of physical activity in population-based studies promoting physical activity. But to achieve generalizable results, it is important to record recruitment, retention and adherence to protocol across the study population. Few studies have documented this process, preferring to focus on measurement decisions and outcomes, and fewer still have reported the views and experiences of adolescent participants. In this paper we have set out a number of challenges, and suggested some solutions, which we believe will be of value to future similar studies.

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Conflicts of interest: None declared.

Key points

- If worn properly, accelerometers can provide an important objective measure of physical activity in population-based studies promoting physical activity.
- To achieve generalizable results, it is important to examine ways in which recruitment, retention and adherence to protocol can be maximized across the target population.
- This paper examines the views of young people who were asked to wear accelerometers for a community study, reasons for non-adherence and possible incentives to improve adherence in large-scale trials with young people.

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Risk factors of preterm birth and low birth weight babies among Roma and non-Roma mothers: a population-based study

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Background: In 2009, 8.4% of live births in Hungary were low birth weight (LBW) and 8.7% were preterm (PTB). Roma are disproportionately represented in Northern Hungary where LBW and PTB are highest in the country (10.3% equally). This study evaluates the risk factors for LBW and/or PTB among the Roma and non-Roma populations in two Northern Hungarian counties. Methods: We conducted a retrospective cohort study of 5469 non-Roma and 2287 Roma mothers who gave birth in 2009. Women were visited by the Maternal and Child Health Service nurses and completed in-person structured surveys on demographic, socio-economic, cultural and lifestyle factors. These data were combined with biometric data from hospital records. Bivariate statistics and a logistic regression analyses were used to determine risk factors for LBW and PTB. Results: Roma had a higher incidence of PTB and LBW babies compared with non-Roma women (PTB 9.9% vs. 7.1%, LBW 12.2% vs. 6.5% \(P=0.001\)). However, ethnicity was not related to PTB and LBW in multivariable analyses, when controlling for socio-demographic and lifestyle characteristics. Factors associated with LBW and PTB include being underweight, advanced maternal age, and smoking. Conclusion: Strategies that ensure healthy lifestyles must be well integrated in family-based interventions and in the schools, with special consideration for Roma women who have a higher prevalence of deleterious lifestyles and poor birth outcomes. Ensuring a healthy body weight and no smoking has important implications for the mother and foetus.

Introduction

Socio-demographic and lifestyle factors, such as maternal education, poverty, stress, smoking and alcohol, can influence birth outcomes namely through the maternal–foetal supply.1–3 Recent comparative studies of birth outcomes between Roma and majority populations of Central Europe have been published.4–6 Based on these reports showing unfavourable birth outcome of Central European Roma,7–9 we conducted a retrospective cohort study to compare risk factors for preterm (PTB) and low birth weight (LBW) among Roma and non-Roma women in the regions with the highest percentage of the Roma population. Recent Hungarian studies have shown that Roma often have poor health resulting from low socio-economic status (SES), severe social exclusion, behavioural patterns and the environment all of which could influence birth outcomes.10–14

In the 2000s, the proportion of LBW (<2500 g.) and PTB (<37 weeks gestation) levelled off at ~8% of all live births in Hungary.15 In 2009, 8.4% of all babies in Hungary were LBW at birth, which is the highest among European Union (EU) member countries (Greece 9.6%, Bulgaria 8.5%).16 The same year, the EU-average was 6.8%, and the lowest proportion was reported in Finland (4.3%). The last retrospective and nationwide study about Roma babies born in 1973–83 hypothesized that Hungary’s PTB/LBW rates have stagnated due to the rapidly growing Roma population and their disproportionately high rates of poor birth outcomes.17

In 1991, according to rough estimates, the Roma population size was 400 000 to 600 000, i.e. 4–6% of the total population.18 In 2001,