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Review article

Engaging Adolescents in Contemporary Longitudinal Health Research: Strategies for Promoting Participation and Retention

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Purpose: High (and nonselective) recruitment and retention rates in longitudinal studies of adolescence are essential for illuminating health trajectories and determinants during this critical period. Knowledge of optimal recruitment and retention strategies must keep pace with emerging challenges and opportunities, such as the shifts towards digitally-based data collection.

Methods: We used a narrative review approach to synthesize research on promising recruitment and retention strategies for optimizing engagement in the next generation of longitudinal adolescent health studies.

Results: We identified a small number of well-evidenced strategies, emerging challenges and opportunities for recruitment and retention in contemporary studies, and key evidence gaps. Core recommendations include the use of well-evidenced strategies (e.g., incentivizing participation, reducing barriers and burden, and investing in building positive relationships with participants) and coproducing recruitment and retention strategies with adolescents and parents of adolescents.

Discussion: More research is needed into successful recruitment/retention strategies for digital/remote data collection methods, but initial evidence suggests that adopting principles and adapting well-evidenced strategies from traditional longitudinal studies is promising.

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IMPLICATIONS AND CONTRIBUTION

Optimizing recruitment and retention of adolescents in longitudinal health research is crucial. This narrative review synthesizes evidence on promising strategies (e.g., incentive use, barrier reduction, building relationships, and coproducing strategies with adolescents and parents), discusses emerging challenges and opportunities for recruitment and retention in the digital age, highlights evidence gaps, and provides recommendations.

Longitudinal research in adolescent populations is essential for illuminating the trajectories and determinants of health in and beyond this critical period [1,2]. Sustaining participant engagement over years and decades is challenging and relies on recruitment and retention strategies that consider the unique challenges of research in adolescence. To inform such strategies, especially considering the increasing shift towards remote and

digitally-based methods, we review the evidence on optimizing recruitment and retention of adolescents in contemporary longitudinal health studies.

There are numerous unique challenges for engagement in longitudinal adolescent health studies. Adolescence is a transitional period of considerable physical, cognitive, and social change [3]. Research participation must compete with the developmental tasks and busy schedules that occupy young people during this period and studies must implement engagement strategies that are responsive to relevant developmental changes, such as increasing autonomy [4–6].

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The presence of multiple stakeholders also creates challenges. As well as adolescents themselves, caregivers must often be convinced of the value of a study to provide consent [7] and in dyadic or multi-informant studies, it is additionally necessary to implement strategies for engaging them as participants [8]. Given the importance of schools in shaping health and the opportunities offered for recruiting representative samples through them, school-based data collection is common [9,10]. This makes school communities further stakeholders to be considered in engagement strategies. School transitions can also create retention challenges [11], with adolescents surveyed near the end of middle school or secondary school being especially prone to attrition due to higher rates of absenteeism, dropout [12], and leaving school [13]. Many health-related topics of key interest in adolescence (e.g., suicidality, sex and sexuality, substance use, violence, and risk-taking or criminal behavior) may be perceived as sensitive to any of these stakeholders. As well as ensuring appropriate safeguarding, researchers are thus, faced with the challenge of gaining the trust of adolescents, parents, and schools to collect these data [14]. However, if their buy-in can be secured, caregiver and school involvement may be leveraged to improve adolescent engagement [15].

The challenges of engaging adolescents in research may be compounded for some groups who could be ‘harder to reach’ related to a variety of sociodemographic or contextual factors. Among adolescents, evidence has identified male sex/gender, socioeconomic disadvantage, poor academic performance, parental divorce, unemployment, and low educational level as predictors of low engagement [16,17]. There are several potential mechanisms. Marginalized adolescents may mistrust the research process or see limited benefit for their community [18,19]. At the same time, their lives could be less stable, making them harder to contact [20]. Marginalized adolescents may additionally present themselves as nonconforming to “outsiders” (researchers) in front of peers and seek to avoid the scrutiny of “authority.” Reluctance to participate may be more pronounced when the surveys involve some sensitive measures (e.g., sexual activity, drug abuse) [19].

Given these challenges, longitudinal studies in adolescence often suffer from (selective) engagement and retention difficulties [21]. To identify promising strategies to minimize these issues, we use a narrative review approach. In contrast to systematic reviews, narrative (or ‘purposive’) reviews are particularly well-suited to broad research questions that benefit from the flexibility to generate more expansive insights and which may draw on methodologically and/or theoretically heterogeneous evidence [22,23]. Evidence from diverse methodological approaches offer insights into strategies for the engagement of adolescents in longitudinal studies, including observational studies [8,24] systematic reviews and meta-analyses [25,26], experimental studies [27,28] the application of theoretical models [29,30] case studies [6,31,32] and qualitative studies [6,33,34]. Further, while direct research into strategies for the recruitment and retention of adolescent participants in longitudinal observational research remains sparse, insights may be gained from research in adjacent areas, such as the analysis of strategies in randomized controlled trials with adolescent participants [35].

Recruitment and Retention Strategies

A wide range of recruitment and retention strategies have been proposed in general longitudinal and health studies, with 1 review identifying almost 1000 strategies used in in-person follow-up health studies alone [25]. These relate to planning and reporting (e.g., publishing a recruitment and retention protocol) contacting and tracing/recontacting (e.g., using locator forms and between-wave mailing to obtain and maintain contact details), and securing (continued) participation (e.g., offering incentives, minimizing barriers such as facilitating transport). A handful of these have been evaluated in experimental designs [28,36–38] and the most widely used have been evaluated in systematic reviews and meta-analyses [25,26,39–41]. However, not all strategies are easy to evaluate in experiments or meta-analyses, therefore, qualitative and descriptive research also has an important place in informing engagement strategies.

Taken together, studies point to only a small number of well-evidenced strategies for improving participation. One review of population-based cohort study retention strategies [39] identified 45 strategies; however, few were effective. Offering incentives was the most effective strategy; however, reminders and flexibility in data collection mode and scheduling also had a positive effect. Another review [26], identified 95 retention strategies used in health longitudinal cohort studies in the categories of barrier reduction, community-building, follow-up/reminder, and tracing. Only three strategies were significantly related to retention: offering alternative methods of data collection such as telephone or face-to-face interviews (86.1% vs. 76.3%); completion of locator forms at baseline (90.9% vs. 78.1%) and; not using mobile phone call reminders (80.6% vs. 72.7%). Further, studies using at least 1 barrier reduction strategy had better retention than those using none (81.1% vs. 70.7%); however, retention was worse in studies that used at least 1 follow-up/reminder strategy (76.4% vs. 86.1%). There were no effects of using at least 1 community building nor at least 1 tracing strategy on retention [26]. The conclusions of these reviews were echoed in a review of adult observational health studies [41] which found that there were very few effective strategies for improving response rates. These varied by population (patient vs. nonpatient) and study design (web, paper questionnaire, interview) but included using shorter questionnaires, prenotification, more expensive mailing types, and incentives.

None of these reviews focused on adolescents and those that included adolescent samples did not report analyses stratified by developmental stage. This leaves a critical gap given that many strategies will not be applicable to, or will require adaptation for adolescents (and their caregivers in multi-informant or dyadic studies). Next, we discuss how the best evidenced recruitment and retention strategies may apply to longitudinal adolescent health studies.

Incentives

Incentives to motivate participation have been consistently supported by review and experimental evidence [39,42]. The effects of varying amounts [43], timing (e.g., presurvey vs. postsurvey completion) [44], and kinds (e.g., gift cards vs. cash) [45] of incentives on retention rates have been explored in

several studies. These show that higher incentives promote better retention, with diminishing marginal increases [43]. Monetary incentives paid unconditionally before a survey have been demonstrated to yield comparable or higher retention rates to conditional postsurvey incentives [44,46,47]. Incentive boosts have also been found to be effective as a way to engage ‘high-effort’ and under-represented respondents [48–50].

However, incentive use in adolescent health studies presents unique challenges. Adolescents report an expectation and appreciation of receiving an incentive for taking part in longitudinal research [6,33]. However, there are ethical questions surrounding their use—particularly monetary incentives—and concerns that they could be coercive for younger adolescents. Similarly, there may be ethical concerns that incentives provided to caregivers could result in them pressuring their child to participate. However, these must be balanced against the consideration of fairly rewarding participants for their contribution and differential rates of incentives paid to adolescents versus adults for the same type of task (i.e., research participation) could represent age discrimination. While offering alternative incentives may be considered as 1 solution, most research has focused on the effects of monetary incentives, meaning that less is known about how to effectively incentivize participation through nonmonetary rewards. Further, compared to monetary incentives, other forms of incentives, such as vouchers, gift cards, study souvenirs may be less effective [39].

Unsurprisingly, given the unresolved questions around best practices in incentivizing participation, there is variation in practice in adolescent longitudinal studies. For example, the US Adolescent Brain and Cognitive Development (ABCD) study typically provided \$200 incentive to caregivers, and \$100 worth of gifts and gift cards to the child, beyond compensation for travel costs and childcare [51], while UK Millennium Cohort Study offered only small gifts to participants in the early adolescent waves [52]. The appropriate strategy will vary across studies, and consultations with adolescents and parents in the design phase of studies can help determine appropriate incentives for a given context [53,54]. The use of consultations for developing retention strategies is discussed in more detail later.

Barrier Reduction

Minimizing barriers and burden is another well-evidenced strategy for promoting recruitment and retention. Common barriers to participation include time and mobility constraints, language difficulties, and complex wording of study materials [34,55]. Some barriers may disproportionately influence certain more vulnerable or marginalized populations, exacerbating their under-representation in research. They may also be compounded in dyadic or multi-informant studies where the barriers may differ for caregivers versus adolescents. Fortunately, issues such as the need to include relevant disclosures as part of safeguarding in the case of risk behaviors (e.g., suicidality) do not appear to be significant barriers to participation [14].

More than twenty barrier reduction strategies were identified in 1 systematic review [26], which also identified barrier reduction as the most effective type of strategy in maximizing retention. Strategies included diverse modes of questionnaire administration, flexible survey scheduling, as well as assistance with transportation, parking, and childcare [26]. For example, the ABCD study provided participating families with bus/metro passes or reimbursed them for taxi costs and they also provided

families with the choice of completing measures over the phone [31]. In a longitudinal trial study of adolescents [30], study staff continuously communicated and negotiated with participants (and/or caregivers) about appointment schedules and offered substantial flexibility in the location, time, and mode of data collection. Online data collection has also been provided as alternative to the in-person approach [13].

Researchers have also aimed to reduce barriers by adapting research materials to better fit participant characteristics, including those from under-represented groups. As language has been shown to act as a barrier and add cognitive burden for participants with lower educational levels or from minority ethnic groups [8,18,56], translating surveys into participants’ mother tongues and modifying wording can help improve engagement. An experimental study [56] found that redesigning a cover letter, including simplifying the language, reducing the length, and changing the style to informal improved the return rate for those with lower educational levels and who spoke languages other than the study language.

Barrier reduction strategies should consider the particular barriers adolescents face, including school and extra-curricular activity schedules, unreliable transportation and limited access to the internet [30]. It is particularly important to be responsive to school schedules. Multiple visits to schools allows the participation of adolescents absent on the first visit [57]. Further, avoiding examination periods in data collection is likely to be important for securing participation [33]. Finally, it is recommended that where possible the participation of a caregiver not be a barrier to (i.e., not an inclusion criterion for) adolescent participation and instead missing caregiver data be dealt with post hoc using statistical missingness methods. This is because parental participation may be selective with respect to key characteristics and thus contribute to selection biases where adolescents would otherwise want to take part [8].

Relationships

Strategies related to creating strong and positive relationships with participants in which they feel valued and respected as individuals are frequently cited as critical for recruitment and retention success [6,29,31,32]. Relationships with caregivers are also important [34], but perhaps especially so in dyadic and multi-informant studies where they are more actively engaged in data collection. Various aspects of relationship-based strategies have been highlighted, including selection and training of staff; maintaining consistent staff throughout data collection; matching staff to participants (which may be particularly beneficial for under-represented groups); and maintaining contact between data collection waves [13,30–33,58,59]. For example, in discussing the recruitment and retention strategy of the ABCD study (which has had a withdrawal rate of only 1.1% since its initiation [7]) the researchers emphasize the importance of rapport-building with families from their first interactions with the study [31]. They propose techniques, such as: memorizing the young person’s name; being friendly and engaging in conversation; showing empathy when sensitive information is shared; and showing appreciation for participants’ time and effort. Another longitudinal health study (of emerging adults with only 3% lost to follow-up) also highlighted positive relationships with participants and strong interpersonal skills in staff as key strategies [13]. As adolescents tend to be concerned with the confidentiality/privacy of their answers, especially of sensitive

information, assurance of confidentiality and careful explanations of specific instances of possible breaches of confidentiality could improve their willingness to disclose and their trust in the research process [60,61]. This, again, may be especially important for under-represented groups.

Although between-wave contact is often implemented mainly for keeping contact details up to date, it may also help with sustaining relationships and, in turn, willingness to participate [27,28]. Indeed, between-wave newsletters or cards appear to be beneficial for participation [13] and although not statistically significant, sending holiday, 'thank you', and birthday cards was among the handful of strategies identified as promising in 1 systematic review [26].

The importance of relationships is underscored by evidence from reports from adolescent participants (or prospective participants) and their caregivers [33,34,62]. For example, adolescent participants in a recent focus group study noted that they would value in-person contact in a longitudinal health study and that study staff should be consistent and non-judgemental [33]. Some participants indicated that they would prefer to build a relationship with study staff prior to longitudinal study participation. Similarly, in a survey of adolescent participants from a recent post-traumatic stress disorder trial study, 22% endorsed a consistent and reliable contact, 20% the same interviewer, and 12% 'thank you' cards as a facilitator [35]. Staff empathy was added as an additional category post hoc because it was frequently mentioned as a facilitator in an open text field (by 4% of participants).

It is helpful to conceptualize strategies based on positive relationships in connection with other strategies [13,31]. For example, providing incentives and anticipating and proactively addressing barriers can convey a message of respect and value to participants [13].

Coproduction

Consultation, codesign, or coproduction of recruitment and retention strategies can be used as an overarching approach to optimize retention, including designing study-specific implementations of well-evidenced strategies. Indeed, it is important that strategies take into account context, as some strategies may be more relevant or influential in some contexts than others (e.g., appealing to altruistic motives may be more effective in clinical populations where participants may be especially motivated to contribute to research that helps others with their condition).

As well as fulfilling an ethical obligation for young people's voices to be heard in matters that affect them (as per the UN Convention on the Rights of the Child [63]), it has been argued that there are strong benefits of engaging young people in codesign/production for recruitment and retention [64]. Young people and their caregivers can, for example, advise on ways to make the study most appealing, to reduce barriers and burden, on appropriate incentives, and can become actively involved in the recruitment. In dyadic and multi-informant studies, more extensive consultations with caregivers as well as adolescents may also be merited, to understand their perspectives as participants.

A number of longitudinal studies involving adolescents have employed methods such as young persons' advisory groups to seek input on recruitment and retention strategies and noted strategy improvements made as a result [32]. The Millennium

Cohort Study, for example, used focus groups and interviews with young people and their parents, to inform the participant engagement strategy for their age 14 wave [6]. These provided insights such as young people's contact preferences (they liked to be contacted by mail), their appreciation of the incentives provided, their interest in what difference study findings make in the real world, and their views on design aspects and clarity of study materials. They also explored participants' willingness to answer questions on sensitive topics and this helped establish design features to maximize responding on these topics. These included a self-administered questionnaire section, routing around questions where the respondents had little experience (e.g., participants were only asked follow-up questions about sexual experiences if earlier answers indicated that this was relevant), warnings about upcoming sensitive remainders, reminders of the confidentiality of answers, the possibility to skip questions, and a 'hide screen' option to facilitate privacy. Similarly, in the Toronto Teen Survey adolescent sexual health study, a Youth Advisory Committees provided advice on designing youth-friendly protocols, format and wording of the consent form (e.g., transforming the consent form into a Q&A format), and devised unconventional safeguards for participants' privacy (e.g., designing the survey into booklets to shield answers). They were also present to introduce and facilitate survey sessions to promote honest responses [65].

Another recent study [33] described insights gained from focus groups conducted with young people on the topic of recruitment and retention in longitudinal adolescent health studies. Rich insights were gained related to young people's expectations about what information should be included in a recruitment flyer, the importance of interest and relevance for participation (and how studies can be framed and incentivized to promote participation), and barriers to participation. For example, participants indicated that they would prefer for study activities to work around academic commitments such as examination periods and to participate with friends, that they would value personalized feedback, and that they considered £10/hour a reasonable compensation for their time. Responses also included insights on preferred recruitment and contact routes, and highlighted young people's preferences for easy, flexible data collection, and for approachable, nonjudgemental, and consistent staff collecting data.

However, despite case study and anecdotal evidence for the value of coproduction strategies and documented benefits from case studies, there has been little formal evaluation of their effects on recruitment and retention. There is also little published guidance on how to optimally implement coproduction approaches, including in the context of the designing recruitment and retention strategies [64] and further research on how to optimize the insights gained for enhancing engagement strategies would be valuable. It is also important to note that their findings may be highly context- and study-specific (e.g., expectations about payment may depend on factor such as local wages), therefore, consultation should ideally be built into every new study. Further, coproduction tends to involve only small numbers of the target population meaning that the views shared may not reflect the preferences of all prospective participants. Finally, researchers should ensure the inclusion of under-represented participant groups and be sensitive to their experiences in the coproduction process to avoid reinforcing their marginalization in research [66].

Table 1

Examples of digital methods for data collection and their advantages and disadvantages for participant engagement

Digital data collection method	Advantages for engagement	Disadvantages and challenges for engagement
Online surveys	The fact that participation is possible solely online may help reduce time and travel-related barriers to participation. They can also incorporate elements such as gamification or other interactive elements to make data collection more engaging (however, the design of these elements needs to be careful to avoid negative effects on responding/data quality) [87]. More so than EMA data collections, online surveys completed in a single session are feasible to 'supervise' via videoconference, providing opportunities for relationship/rapport-building.	Internet access can create selection biases for online surveys; however, as coverage increases this is becoming less of an issue. Compared with in-person data collection there may be fewer opportunities to build relationships with participants.
Smartphone-based surveys (e.g., ecological momentary assessment)	Smartphone-based applications for data collection can leverage the fact that smartphone use is well embedded in the daily routines of young people [88]. As a remote data collection method, they can remove some barriers to participation. In principle, they can facilitate tailored protocols/adaptive designs that are responsive to indicators of risk of disengagement through 'ecological momentary interventions' [84]. They can be used to communicate regularly with participants, including providing feedback on response rates or responses. They can also be used to gamify data collection or include other interactive elements that make data collection more interesting or engaging [89].	The use of smartphone-based data collection could lead to selection biases based on smartphone access or create additional barriers due to application compatibility issues or technological glitches [58]. There may be issues with responding at certain times, such as in school hours (where smartphone use may not be allowed or where young people may feel self-conscious responding) and there may be a risk of 'digital overload' with too many notifications/reminders [90]. Compared with in-person data collection there are fewer opportunities to build rapport with participants; however, this could be mitigated via providing on-boarding support and/or check-ins via videoconference.
Microinteraction EMA e.g., using a smartphone watch	Microinteraction EMA [91] can reduce the burden of data collection dramatically by reducing it to just one or two touches on a smartwatch.	This technology provides very little opportunity to build relationships with participants. Further, when participants already wear a watch, they may prefer not to switch devices [58]. Some participants who, for example, experience sensory sensitivity issues may also find the use of a smartwatch an important barrier to participation.
Passive smartphone-based data collection e.g., location monitoring or smartphone app use	The passive collection of data via smartphones (e.g., via smartphone-based applications that can gather information on location, application usage, messaging content [92,93]) reduces participant burden by removing the need for active engagement/responding. In combination with survey measures they can provide insights into the reasons for missingness as well as information that can be used to model missingness and address biases related to non-random missingness.	Passive data collection could feel intrusive [33] and may result in selective participation as those who are comfortable with passive data collection may differ systematically from those who are not. Further, although the burden of active engagement may be reduced, other burdens may be created [94]. For example, some applications for passive data collection may drain the battery life of smartphones [95].
Sensor-based technology e.g., accelerometers	Like smartphone-based passive data collection, sensor-based technologies (e.g., body worn or bedside sensors to measure sleep parameters, or recording devices) reduce the burden of actively responding to survey questions and to provide information on missingness when combined with surveys [96]. Further, providing participants with access to the technologies can act as an incentive. [58]	Having to wear, charge, receive, or return a sensor (or sensor data) to the study team can create additional burdens. Some sensors may be less acceptable than others (e.g., those worn on the body) or to certain groups due to, for example, sensory sensitivity issues or symptoms of disorder eating (e.g., in the case of activity trackers) [58]. As noted above, wrist-worn devices may be a barrier to participation where participants already wear a watch.

Recruitment and Retention Strategies in the Digital Age

The above discussed strategies have largely been developed in the context of traditional (e.g., in person or mail survey) longitudinal studies. However, in recent years, there has been increased use —accelerated by COVID-19— of digital methods for recruitment, retention, and data collection (see Table 1 for examples). Digital methods can create new opportunities for recruitment and retention [67,68]. Many longitudinal studies involving adolescents, for example, leverage social media [26,32]. These are widely used by young people and provide a means of building a study image and relationships with participants, as well as providing an additional relatively stable point of contact, which may be particularly advantageous for engaging more marginalized groups [67,69]. A recent qualitative study of adolescents' views on health study participation highlighted social media as a potentially effective recruitment route, with Instagram mentioned as the top option [33].

Data collection in adolescent longitudinal studies also now frequently include an online mode as an alternative [13] or primary/sole data collection mode [70] and smartphone-based ecological momentary assessment (EMA) is also on the rise within longitudinal studies [71]. Compared with traditional modes of data collection, these digital methods provide opportunities to reduce participant burden [41] and in technology facilitated data collection, providing the technology (e.g., Fitbit type devices) can act as an incentive [58]. EMA designs can facilitate dyadic data collection involving both adolescents and their parents, friends, or romantic partners [72] and technological solutions such as Bluetooth or GPS triggered prompts based on proximity can help with gathering concurrent informant data only when relevant [73].

However, digital methods can also create new challenges and it is questionable whether the potential benefits for recruitment and retention are being realized. For example, recruitment via social media may allow more direct

Table 2
Key recommendations

Recommendation	Description
Incentivize participation	Offering rewards such as monetary rewards, gifts, or vouchers can improve engagement; however, this must be balanced with ethical concerns and it must be ensured that an incentive does not become coercive. Access to technologies such as smartwatches may act as an incentive in remote measurement studies.
Build rapport/relationships	Having positive relationships with participants can improve engagement. This may be promoted via selection and training of staff to equip them with rapport-building skills and through careful crafting of the communications between the study and participants. In remote measurement studies, opportunities to build relationships in person may be limited; therefore, consideration to online methods of building relationships should be given.
Minimize barriers and burden	Reducing barriers to participation (e.g., travel, clashes with examination time) and minimizing the amount of time and effort that participants expend enrolling and taking part are important for engagement. Remote data collection may offer an advantage in this respect; however, they can also come with additional sources of burden (e.g., having to keep devices charged or the necessity of dealing with technological glitches), therefore, it is important to identify and address potential barriers and burdens associated with a particular remote measurement design.
Consultation, codesign, or coproduction	Consulting with the target population is valuable for developing effective engagement strategies, including establishing a suitable incentive, generating ideas for building relationships with participants, and identifying and addressing barriers and unnecessary burden for participants.

recruitment and autonomous participation for adolescent participants but creates challenges with respect to ensuring parental consent and supervision. The use of social media must also keep pace with trends in platform popularity among target participants [33] and can be time intensive for engagement [67]. One adolescent study noted that social media recruitment can be expensive and yield high numbers of ineligible participants [74], and for longitudinal studies more generally, they may not yield as much engagement as study websites [67]. A recent meta-analysis of retention strategies [26] found no significant benefit for retention of using study websites and social media profiles for keeping participants up to date. More broadly, online recruitment (and remote data collection) may make building relationships with participants more challenging. Another challenge associated with online data collection is the fraudulent responses generated by bots that is malicious software programmed to automatically complete tasks online [75]. The infiltration of bots has become a significant concern, especially when surveys involve monetary incentives, as they threaten data integrity and increase study costs by inadvertently rewarding bots and incurring costs in the prevention, detection, and exclusion of fraudulent responses [76]. Various strategies have been proposed to address bots [77,78], both preventative to reduce bot responses (e.g., presurvey screening, not sharing links publicly, and embedding CAPTCHA verifications) and exclusionary to detect and exclude bot responses based on survey metadata (e.g., IP addresses) and response patterns (e.g., attention checks, speed of completion) [79].

Some digital data collection methods such as EMA or wearable devices can be experienced as more effortful or intrusive than traditional methods. Further, unequal access to or comfort with the relevant technologies contributes to nonrandom participation [58,80] and technological issues such as difficulties with data collection applications can add barriers [80]. Therefore, technology (and internet) access and familiarity of the target participants should be taken into consideration when planning data collection [30]. Efforts to design survey platforms compatible with a wide range of devices and operating systems, and to streamline the survey procedures are likely to promote participation and reduce possible bias [33,58]. In a recent qualitative

study that consulted adolescents on these issues, adolescents indicated they would prefer to use an app for survey data collection and that this should be easy to use, free, and not require much phone storage. It should not track GPS, which they would find intrusive [33]. The adolescents also indicated that they would be happy to wear a device, such as a physical activity monitor. Regarding keeping in touch, they indicated that app notifications and text communication were acceptable (with texts preferable to phone calls and emails not necessarily checked regularly), with minimal app notifications preferable. For dyadic and multi-informant studies, the corresponding preferences of caregivers were not explored.

Overall, little concrete is known about optimizing engagement in digital longitudinal adolescent studies [26,58,67,68,81]. Most research has been small scale, has not specifically focused on adolescent longitudinal research, and very few strategies have been evaluated and shown to be effective. For example, the only strategy supported for improving response rates to web-based health surveys in a recent meta-analysis was providing conditional lottery tickets as incentive [41]. A recent rapid review of e-engagement strategies [81] also found very few that had been well-evaluated. Promising strategies were not specific to adolescent populations, but included the provision of personalized feedback, the use of more interactive methods (e.g., including videos or human involvement), and text or digital reminders. A recent scoping review of recruitment and retention strategies in remote measurement studies tentatively identified targeting specific participant profiles, providing incentives and nudges, and reducing study complexity (from the participants' perspective) as promising strategies; however, this was based on limited evidence [68]. Further, there is next to no evidence on addressing the challenges of achieving high dyadic compliance in remote measurement studies involving adolescents with their parents, peers, or romantic partners. One study found that minority status and lower income levels was associated with lower compliance in a dyadic EMA study of mothers and children and that engagement was higher when the participants were together [15]. They also presented preliminary evidence that mothers and children may respond differently to reminders, highlighting that tailored engagement strategies may be needed for parents versus young adolescents.

Future Directions

In future studies, greater focus on strategies for the developmental period of adolescence and associated challenges such as engaging *both* adolescents and caregivers is needed. This includes strategies that can address the under-representation of more marginalized groups [20,82,83]. Studies using experimental designs to rigorously evaluate the effects of strategies are especially needed, complemented by between-study meta-analytic level investigations where experimental designs are challenging (e.g., to evaluate codesign/production). Further, more consideration should be given to cost-effectiveness of recruitment and retention strategies [59].

There is also a clear need for further research on adapting and innovating engagement strategies for adolescent health studies in the digital age, especially those employing remote measurement techniques. The use of the internet and smartphones is often noted to be embedded in the lives of many young people, which may offer engagement opportunities. One promising direction facilitated by the richness and timeliness of data gathered remotely, passively, and online is the prediction of imminent dropout and associated provision of 'just-in-time' interventions within adaptive designs that can counteract predicted dropout [84]. In these strategies, dynamic predictions of dropout can be made based on incoming information about nonparticipation risk from survey responses and response patterns (e.g., response rates and latencies) to trigger a strategy designed to prevent dropout or to increase responding. However, at present the predictive accuracy of attrition algorithms remains relatively poor [85]. Complementing these data-driven approaches, another promising direction is the greater integration of psychological models (e.g., behavior change or social marketing models) that can provide insights into how prospective participants may respond to interventions to promote participation [86]. Finally, although there have been positive trends in the explicit reporting of recruitment and retention strategies [24] clearer documentation of these strategies and their extent of success will benefit progress in illuminating effective strategies.

Conclusions

Evidence supports several strategies that can benefit recruitment and retention in adolescent health studies, including incentivizing participation, minimizing barriers and burden, building positive relationships, and coproduction (see Table 2 for a summary). The latter can help establish how well-evidenced strategies can be applied in particular contexts and to inform additional study-specific strategies. Though largely established within the context of more traditional adolescent health studies, early evidence suggests that the principles underlying these strategies generalize to studies conducted in the digital age. However, much remains to be learned about specific effective recruitment and retention of adolescents in digital age longitudinal health studies.

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