The Landscape of Digital Tech Disengagement Solutions for Early Adolescents: Insights from a Systematic Scoping Review and App Analysis

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The widespread use of digital devices among children and teenagers has raised concerns about overuse, particularly for early adolescents, who have unique developmental needs and engage with technology more frequently than other age groups. A challenge for designers and researchers interested in contributing solutions is a lack of synthesized design guidelines and characterization of the current state-of-the-art. In this paper, we present a systematic scoping review of academic literature and an analysis of 47 apps, providing a comprehensive characterization of existing tech-mediated solutions for early adolescents. Our review covers literature from two major databases (ACM DL and IEEE Xplore) spanning the past 10 years (2014-May 2024), following the scope of prior similar reviews. The app analysis includes Google Play and Apple App Store apps with features targeting tech overuse, excluding general-purpose apps (e.g., social media, games) and apps without a free trial version. Our findings highlight researchers' design recommendations for promoting tech disengagement in this demographic (e.g., supporting collaborative rule-setting and self-monitoring, maintaining privacy, addressing diverse user needs), while revealing that existing apps tend to prioritize restrictive measures, overlooking self-regulation and active parental engagement. Our findings also identify areas of agreement and potential misalignments between current digital interventions and prior research on target users' preferences.

CCS Concepts: • **Human-centered computing → Human computer interaction (HCI) →** HCI theory, concepts and models

Additional Key Words and Phrases: Technology Overuse, Technology Disengagement, Digital Intervention, Early Adolescents, Parents, Parental Control Applications, Systematic Scoping Review, App Analysis

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1 Introduction

Technology has become an integral part of children's and teenagers' lives, offering numerous benefits in education, socialization, and entertainment [11,46]. However, the pervasive use of

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smartphones, tablets, and other devices has raised concerns about overuse, which is associated with negative outcomes, such as cognitive delays, insomnia, depression, and obesity [25,56,75,83]. Recent surveys have shown that despite these negative impacts, nearly half of the U.S. teens use the internet "almost constantly" [64,65]. Naturally, parents are concerned and employ various mediation strategies to manage their children's technology use, but they often face challenges as children frequently bypass these rules [70]. This issue of tech overuse is especially prevalent among early adolescents, who tend to spend more time with technology than other age groups [36]. As they develop a sense of autonomy, they often resist parental restrictions, making it increasingly challenging for parents to maintain rules and boundaries [68], which can lead to frequent parent-child disagreements [21,24].

Extensive research has explored parental mediation strategies [15,47,53,55,61,71,72], children's and teens' tech usage patterns [9,12,22,35,62], and their responses toward parental mediation [6,29,51]. Despite the attention paid to this topic, there are few established guidelines for designing digital interventions to address tech overuse among early adolescents, who have unique developmental needs [73,79]. Moreover, to assist parents in managing this issue, hundreds of parental control applications have emerged, marketed to a broad spectrum of ages, however, it is unclear if their features meet the needs of this specific age group. Without synthesized design guidelines and a characterization of the current state-of-the-art, researchers and designers lack direction on how to further contribute promising design solutions.

To identify and characterize current research and applications relevant to early adolescents (ages 11-14 [73]), in this paper, we conduct a landscape investigation of existing tech disengagement solutions. For this investigation, we define tech disengagement solutions as those that promote a balanced use by reducing overuse of technology, as opposed to complete non-use. Our investigation employs a multifaceted approach, combining a systematic scoping review of academic literature with an analysis of a sample of available parental control applications. Our goal is to uncover common themes in researcher-proposed recommendations and underexplored areas within the design space of potential digital interventions. More specifically, this investigation is guided by the following research questions: 1) What do researchers recommend in terms of intervention design for promoting disengagement from tech overuse among early adolescents, and to what extent do these design recommendations align or misalign with early adolescents' and parental preferences? 2) How well do existing applications align with user preferences, and where should future design efforts focus?

To address these research questions, our scoping review identified relevant HCI literature from two prominent databases and determined common patterns by analyzing researchers' design solutions, recommendations, and implications. Despite reviewing 1366 potentially relevant abstracts and completing full-text reviews on 78 papers, we found only 15 relevant research articles that include our target age group, underscoring the need for further research efforts concentrating on digital solutions targeting early adolescents. Additionally, through an environmental scan of available parental control apps, we sampled 47 apps that offer features related to tech disengagement. We systematically analyzed these apps to assess their implemented design strategies and focus. Our paper builds on prior work exploring an initial design space for early adolescents' digital interventions, which highlights areas of preferred solutions for both early adolescents and their parents across different design dimensions including agency, parental engagement, mentorship approaches, and motivation types [19]. We use this design space as an analysis tool to further evaluate the alignment between researchers' recommendations, current app focus, and the needs of our target users.

Our findings from the scoping review highlight important researcher recommendations for promoting tech disengagement, such as involving children in collaborative rule-setting and self-monitoring, maintaining their privacy, and addressing their diverse needs. We identify 14 key design mechanisms from the HCI literature that align with existing data on our target users' preferences [19]. Our app analysis reveals that while some apps support these recommendations,

most apps do not meet both parents' and early adolescents' preferences. Most of the apps focus on restrictive approaches instead of fostering self-regulation, lack features for active parental engagement, and rely on external motivation through rules and restrictions. Our findings suggest potential areas for future design based on recommendations from HCI researchers and gaps between the current app focus and the preferences of target users.

Our contributions are: 1) We provide insights into the landscape of current digital solutions, including both academic research and existing parental control apps. 2) We identify researcher-suggested important design mechanisms for digital interventions addressing early adolescents' tech overuse. 3) We highlight the placement of the apps within an early adolescent-centric design space to reveal alignment and misalignment with user preferences identified in prior work.

2 Related Work

2.1 Strategies and Tools for Managing Tech Use in Early Adolescents

To address the issue of tech overuse, parents often employ different strategies, such as restrictive mediation, active mediation, and co-monitoring [1,9,37,37,41,54,72,74]. In restrictive mediation, parents impose restrictions on children's digital engagement, which includes controlling the kind of content they will have access to and limiting the time spent on those activities [34]. On the other hand, active mediation involves parents engaging in discussions with children about appropriate content and usage to promote awareness of both the benefits and drawbacks of technology [9,34,55]. Another approach is co-monitoring where parents and children monitor each others' usage, promoting shared responsibility [1]. The effectiveness of these strategies, particularly for early adolescents, is debated [37]. For instance, some studies find restrictive strategies ineffective for early adolescents due to these youths' need for independence, while co-monitoring, despite being empowering, can cause family tensions [1,41]. These conflicting findings underscore the need for further exploration of mediation solutions targeting this age group.

In addition to these strategies, many parents employ different kinds of technological interventions, a strategy known as technical mediation [9]. For example, numerous parental control applications have been designed to assist parents in monitoring and controlling their children's tech use. In the context of promoting children's online safety, studies evaluating parental control apps have found that most of these tools are parent-focused and often ineffective [29,81], resulting in reluctance towards their use [70]. We contribute to this literature by investigating whether and how the current digital interventions align with the needs and expectations of early adolescents in terms of supporting tech disengagement.

2.2 Prior Research Characterizing Academic Literature and Analyzing Digital Solutions

Researchers have systematically reviewed literature on tools that help parents supervise and control their children's online media usage [5,39,50]. For instance, Monteiro et al. reviewed literature on parental control apps and educational interventions designed to enhance children and adolescents' awareness of online safety [50], and Altarturi et al. conducted a comprehensive bibliometric analysis of cyber parental control tools, offering a taxonomy and insights into current research practices [5]. While these reviews concentrate on online safety, our paper presents a scoping review of academic literature that focuses on strategies to support disengagement from tech overuse.

Additionally, researchers have analyzed existing parental control apps [3,30,76,80,81] and user reviews [2,30,76] to assess app features, effectiveness, and acceptability. However, these studies also primarily focus on online safety and do not analyze specific aspects addressing children's tech overuse. Similarly, prior work has reviewed self-control apps aimed at reducing smartphone

use and promoting digital well-being [4,14,48], but these apps were not specifically designed for children.

To conceptualize digital autonomy for children in HCI, Wang et al. reviewed prior literature on enhancing children's self-regulation of screen time, promoting online safety, and developing literacy [78]. Although this work included research on self-regulation, it focused on offering design mechanisms to support children's digital autonomy rather than addressing tech disengagement. Additionally, it did not target a specific age group or examine applications aimed at regulating tech use [78]. Building on this work, our paper specifically addresses early adolescents' tech overuse by including both relevant academic literature and applications. Our analyses identify key design concepts and offer insights into how well they align with the preferences of early adolescents, contributing to a more comprehensive understanding of this landscape.

3 Approach

Our landscape investigation of current digital solutions targeting early adolescents' tech overuse utilizes two sources of data: academic literature in HCI and existing parental control apps. First, we conduct a systematic scoping review (see section 4), to characterize researchers' recommendations regarding how digital solutions should be designed to address tech overuse. We also conduct an environmental scan to systematically identify and analyze existing parental control apps aiming to limit children's tech use (see section 6). We utilize an early adolescent-oriented design space proposed in prior research [19] (see section 3.1) as an analysis tool to determine whether researcher-provided design recommendations and the existing apps align with previously collected data on our target users' preferred solutions.

3.1 An Early Adolescent-Centric Design Space for Digital Interventions Addressing Tech Overuse

Based on prior literature related to mediation strategies, parental control tools, self-regulation abilities of early adolescents, and their perceived important design factors, Chowdhury and Bunt proposed an initial design space with four design dimensions: early adolescents' agency, supportive parental engagement, mentorship approach, and motivation type [19]. The first design dimension explores varying levels of agency, aiming to find the right balance between early adolescents' autonomy and parental control. The second explores different levels of parental engagement, ranging from limited to active supportive engagement in the tech disengagement process. The mentorship approach dimension explores the range from peer-based support to parental guidance. The final dimension explores the spectrum between designs that emphasize intrinsic motivators and those that prioritize extrinsic motivators, with the midpoint being a balance of both types of motivators.

Through an elicitation study with early adolescents and their parents, the researchers identified areas of preference within each design dimension [19] (see Fig. 1). To illustrate the range of parent-child responses within these dimensions, the researchers rated the responses subjectively within a range of low, low-medium, medium, medium-high, and high. Since it can be challenging to precisely capture the subtle differences in subjective responses, the researchers discretized the dimensions. Figure 1 depicts the output of this process: using ellipses to indicate where most responses were located, with their width reflecting the variability in users' opinions. We used this design space and associated user preferences as a tool to characterize current design solutions and determine any gaps or misalignments with the parent-child preferences identified in prior work [19].

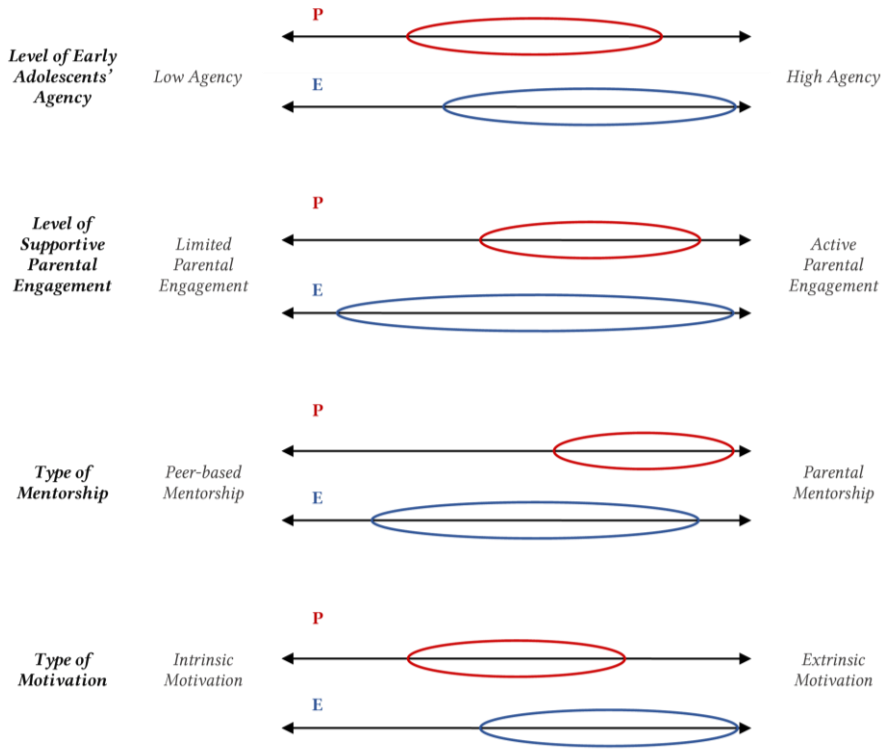

Fig. 1. A visual representation of an early adolescent-centric design space that shows how much early adolescents' and their parents' preferences vary across the four design dimensions (adapted from [19]). The width of the ellipses indicates where most responses are located. The wider the ellipses are, the more differences there are in their opinions. 'P' and 'E' denote the preferences of parents and early adolescents, respectively.

4 Systematic Scoping Review

To identify design recommendations from HCI researchers for designing appropriate tech-based mediation strategies targeting early adolescents' overuse of technology, we conducted a systematic scoping review of existing HCI literature from two prominent databases covering the past 10 years (2014-May 2024). Scoping reviews aim to identify and map available evidence on a topic, synthesize knowledge, clarify key concepts, and highlight gaps in the literature, helping define the research landscape of a given field [7,17,42,52,59]. In contrast, traditional literature reviews often provide a general narrative summary [44,66]. According to definitions in prior work, our scoping review can further be considered a systematic scoping review because we employed a structured and rigorous approach to identifying, selecting, and extracting data from relevant studies [42,59]. We also follow the PRISMA guidelines to ensure a transparent, complete, and structured reporting process [60]. This review aims to address the following research questions: 1) What are the key design strategies recommended for digital interventions addressing children's tech overuse? 2) To what extent do these design recommendations align or misalign with early adolescents' and their parents' preferences identified from prior research [19]?

4.1 Data Collection

We searched for peer-reviewed literature from ACM Digital Library and IEEE Xplore Digital Library databases as they cover high-impact research in HCI and computing-related disciplines. These databases also cover multidisciplinary research, making them the most relevant for our focus on the design and technical aspects of digital interventions. Our choice of databases was further informed by other similar reviews in HCI, which included only one [8,28,63] or both databases [77].

We conducted the search in May 2024. We started by experimenting with various combinations of search keywords that produced relevant results, with guidance from our university librarian. To focus on regulating children's technology use, our search terms covered the target population, technology, usage, and intervention. We generated a search query using these terms as detailed in Table 1. We applied the query within the abstracts of the papers since the abstract typically highlights the research focus. Although our target population is early adolescents (aged 11-14 years), we included additional keywords to capture papers that may use different terms but include children in this age range. Filters were applied to include only conference papers and journal articles published between 2014 and May 2024. We selected a 10-year timespan following the approaches of prior reviews on child-oriented technology and their design ideologies [77,78]. This approach aims to balance capturing recent trends in an evolving technology landscape in addition to current work that builds on established approaches utilized in prior literature. This search resulted in 1386 papers: 1188 from ACM and 198 from IEEE. We used Covidence [84] to manage the review process, which removed 20 duplicates, resulting in 1366 unique papers.

Table 1. Keywords used for database search queries, with 'OR' between each keyword in the rows and 'AND' between the rows

Population related terms	child*, teen*, adolescen*, preteen*, kid, kids, preadolescen*
Technology related terms	mobile, smartphone, media, online, digital, tech, technolog*, internet, game*, device*
Usage related terms	"screen time", screentime, playtime, "play time", use, overus*, usage, addict*, activities, activity
Intervention related terms	regulat*, mediat*, control*, limit*, disengage*, reduc*, interven*, moderat*

4.2 Title and Abstract Screening

Initially, we screened 1366 papers based on their titles and abstracts. One researcher independently screened the entire sample, while two other researchers each also screened half of the full sample. Thus, each article selected in this phase was reviewed by two researchers and, upon agreement, included for full-text screening. We followed the exclusion criteria stated below during this title and abstract screening.

- Papers are excluded if they do not target/include children of any age between 11-14 years old (e.g., if the study only targets young children or university students). If the abstract does not specify an age group but does not meet other exclusion criteria, it is included for full-text screening.

- Papers are excluded if their titles or abstracts do not mention any findings on regulating or limiting children's technology use (e.g., through any system, strategy, survey, parental control app, or game).
- Dissertations (e.g., doctoral consortium), panels, special interest group (SIG) meetings, award talks, demos, keynote abstracts, workshop proposals and position papers, course proposals, books, book chapters, and editorials are excluded.

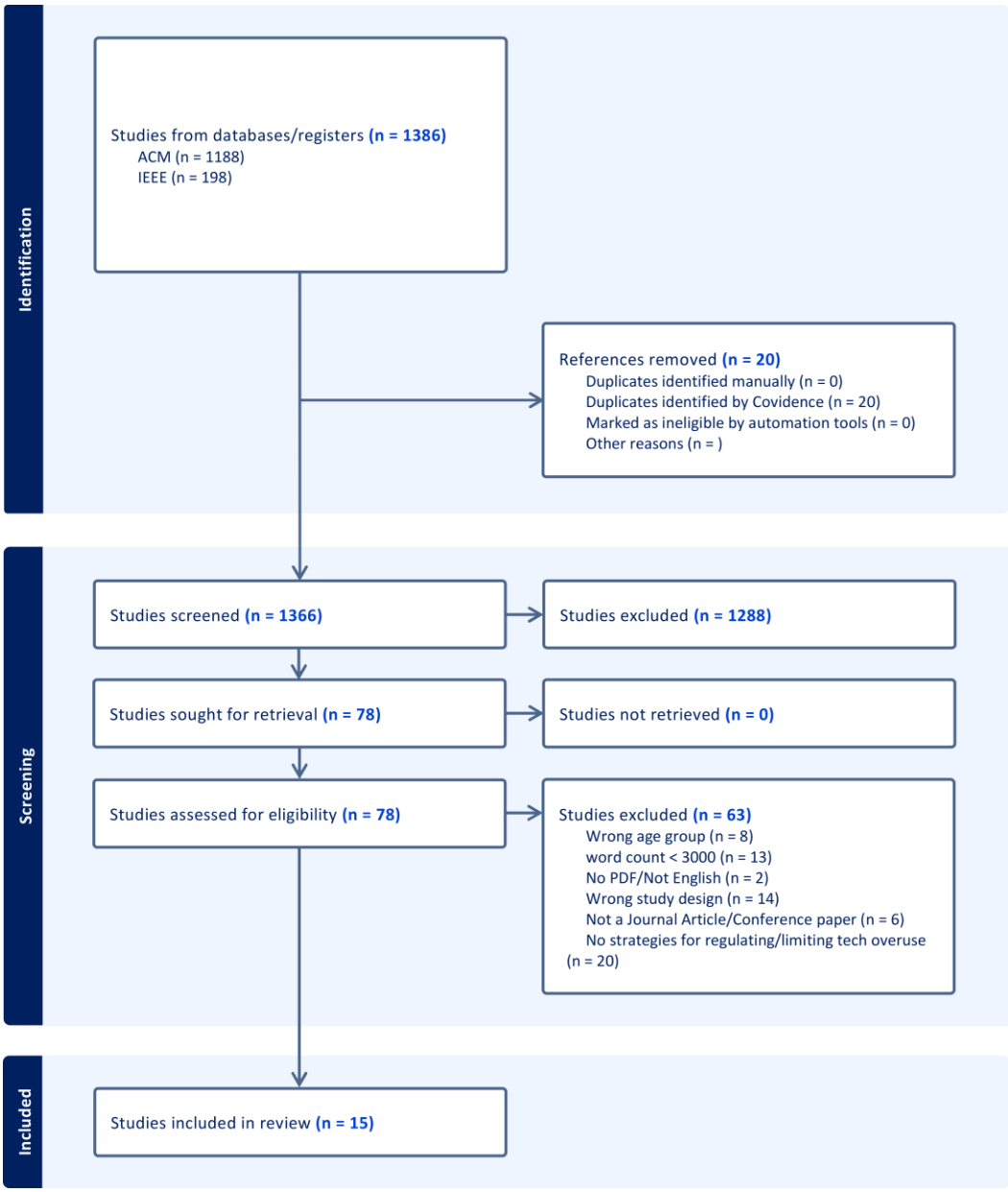

Fig. 2. PRISMA Diagram.

The independent screening revealed 40 conflicts, which were resolved through discussions with a fourth researcher. The process resulted in 78 papers for full-text screening.

4.3 Full-text Screening

The full-text screening was comprised of two stages. One researcher did an initial round of screening to exclude 29 papers for the following reasons.

- Full text is not available.
- Full text is written in a language other than English.
- Paper is less than 3000 words.
- Paper does not target/include children of any age between 11-14 years old.

Then two researchers independently screened the full texts of the remaining 49 papers thoroughly for either of the following inclusion criteria:

- Papers are included if they provide a system, prototype, app, technology, or artefact offering strategies for regulating tech overuse.
- Papers are included if they present a design study, evaluation study and/or system that focuses on regulating technology use and/or provides design recommendations. Review papers are excluded. Survey, interview, or ethnography studies are excluded if no concrete design recommendations for a system to regulate tech overuse are provided; otherwise, they are included.

At this stage, the researchers unanimously included 9 papers, and 14 papers had conflicts, which were resolved through discussions with the fourth researcher. Conflict resolution resulted in a final set of 15 papers (i.e., 63 papers were excluded from the initial set of 78, after full-text screening). The PRISMA Diagram in Figure 2 depicts the detailed workflow.

4.4 Data Extraction

In this phase, two researchers reviewed the 15 papers selected from the full-text screening phase to extract information relevant to our research questions. One researcher collected manuscript metadata (e.g. title, authors, and year of publication), and documented the stated research goals, contributions, participant information, and study design. Both researchers independently extracted the stated design recommendations from the papers concerning the design of digital interventions.

We defined a single recommendation as any sentence, set of sentences, or part of a sentence in a paper that could be interpreted as a suggestion informing the design of digital interventions. We extracted multiple instances of the same recommendation from each paper when they occurred to capture emphasis and variation in phrasing across contexts. Our extracted design recommendations included specific, actionable suggestions, often derived from practical experiences such as co-design or evaluation studies, as well as broader design insights derived from interviews or surveys. While concrete suggestions can provide clear guidelines for intervention design, although potentially less mature, broader insights can offer new ideas and opportunities for exploration.

To identify recommendations related to disengagement, we looked for strategies defined in the papers as aiming to reduce device overuse and promote balanced use. Our review considered recommendations that facilitate tech disengagement either directly (e.g., self-tracking tools, rule-setting) or indirectly (e.g., fostering autonomy, family collaboration). While some design recommendations, such as promoting privacy or parent-child collaboration, could be seen as supporting engagement, we included them based on prior research [19] or the papers' own

framing linking them to disengagement outcomes by enabling early adolescents to develop autonomy in regulating their own tech use.

Researcher-suggested recommendations were typically found in the system design, study findings (e.g., from evaluations, interviews, or surveys), and/or discussion sections. For instance, for papers proposing systems (e.g., prototypes), we included the system's design, and any suggested modifications based on user evaluation as part of the researchers' recommendations. We did not extract statements related to future work if there is no discussion on why it is important or how researchers can incorporate them into design. After data extraction, the researchers crosschecked each others' documentation to ensure accuracy and completeness.

4.5 Data Analysis

We conducted a thematic analysis [13] on all the extracted design recommendations. We started the analysis with a set of 239 design recommendations (including multiple instances of similar recommendations extracted from a paper). Through multiple rounds of coding and grouping, one researcher identified initial themes, which were further developed through discussions with a second researcher (discussed in 5.2). We also used a deductive approach to associate the coded data to specific design dimensions [19] (see section 3.1) to identify researcher-recommended design mechanisms within the design space (discussed in 5.3).

5 Scoping Review Findings

5.1 Overview of Study Designs and Participant Demographics

Among the 15 papers in our final sample, six papers implemented and utilized systems or prototypes specifically designed to regulate children's technology use [16,20,23,43,69,82]. Among these six papers, four gathered users' feedback prior to implementation and conducted further evaluations or field deployments to validate their designs [16,20,23,43]. The remaining papers focused on understanding users' practices, needs, and expectations related to technology use and regulation through methods such as interviews [22,23,26,38,41], surveys [27,32,34], co-design [18], and ethnography [49]. The papers focused on a range of different technological solutions, including various existing software and hardware tools aimed at limiting screen use [22,23,32], participatory parental control services [43,69], an app promoting collaborative outdoor activities to reduce screen time [41], an intervention combining wristbands with a diary reporting system [16], a wrapper application designed to shape social media entry experiences supporting self-regulation [20], as well as voice assistants [82], smart speakers and toys [27].

In terms of participant involvement, four papers engaged parents only [22,23,32,82], while two included entire families [43,49]. Six papers involved both parents and children [16,26,27,34,38,41] and three papers solely focused on children (range: 11-18 years) [18,20,69]. Only one paper specifically focused on early adolescents (aged 11-14) [18], while other papers included broader age ranges. Participant backgrounds also varied in our paper sample, including adolescents with tech abuse [38], smartphone-addicted adolescent patients [16], parents from nuclear families across a broad age spectrum (aged 25-58) [22], and parents from different socio-economic and cultural backgrounds [26,27]. Complete manuscript details of the 15 papers are included in the supplementary materials.

5.2 Key Themes in the Researcher-Suggested Design Recommendations

In this section, we present the themes derived from the qualitative analysis of design recommendations identified in the research articles from our sample [16,18,20,22,23,26,27,32,34,38,41,43,49,69,82]. To support our findings, we include selected quotes from these articles illustrating specific recommendations by the researchers.

5.2.1 Involving Children in Rule-Setting and Self-Monitoring to Foster Self-Regulation. Most research articles in our sample (13 out of 15) advocate for actively involving children in managing their technology disengagement [16,18,20,22,23,26,27,34,38,41,43,69,82], emphasizing that it can foster responsibility and accountability for their tech usage. This approach is seen as particularly relevant for adolescents, who have the capacity to practice self-regulation [18,38]. However, relying solely on self-control methods might not be effective for those struggling with willpower [38]. In such cases, incorporating metrics to assess the level of self-control can provide adolescents with a sense of self-efficacy while also allowing need-based timely parental interventions [16].

> *"It should be possible to establish constructive technology-mediated boundaries aimed at making the adolescent responsible for themselves while respecting their autonomy." - [38]*

Incorporating children's voices in rule-setting for tech disengagement helps them view these rules as fair and within their control, which can, in turn, increase adherence [18,20,34,38,41,43]. Recommended design elements to involve children in rule-setting include letting them choose disengagement durations, select offline activities [43], and negotiate restrictions with parents [69].

Several papers recommend enabling children to self-monitor device usage to help them understand and regulate their behavior over time [16,20,27,38,43,69]. Researchers also suggest incorporating manual reporting and tracking of lifestyle and well-being data alongside phone usage data [16], as well as integrating reflection tools to help children set and identify their goals, promoting mindful technology use [16,20,41].

5.2.2 Respecting Children's Privacy. While monitoring children's tech usage is essential for ensuring healthy and age-appropriate behavior, it is equally important to respect their privacy as they develop autonomy [23,32,38,43]. Intrusive monitoring can create trust issues, negatively impact parent-child relationships, and hinder children's development of autonomy. Although most papers advocated against such practices, one study suggested sharing real-time on-screen monitoring for parental awareness [32], while acknowledging the aforementioned trade-offs. The paper also mentioned offering varying levels of privacy based on children's ages, but did not provide age-specific recommendations [32]. Another paper [38] emphasized that the granularity of personal information disclosure should be mutually agreed upon by both adolescents and parents, and adjusted based on specific situations or comfort levels.

> *"Ultimately, the issue of data granularity should be discussed and mutually agreed upon by parents and adolescents. It might also be useful to adjust the level of granularity in accordance with the situation and wishes of the user." - [38]*

To respect children's privacy, researchers recommend avoiding sharing fine-grained data (e.g., personal detail, or media content), focusing instead on app-level or meta-level information (e.g., app usage duration) [23,38,43]. Suggested alternatives include sharing broad usage categories such as education or entertainment [16,23,38] or providing abstract representations of usage behavior by extracting topical interests through text-mining [43].

5.2.3 Promoting Family Collaboration and Parental Communication through Digital Interventions. Researchers recommend integrating both parental involvement and family-wide initiatives. Papers emphasize the importance of involving parents through open communication about expectations [23,26,38,41,43,69], addressing children's emotions regarding tech use [16,18,27], and providing clear reasonings for restrictions [26,34,41]. Suggested design elements to facilitate such communication include in-app chatting features for discussing device rules and usage among family members [43], prompts to guide meaningful conversations [16,23,41], and scheduling discussions at convenient times [16,23].

> *"[...] designs could provide guiding prompts to parents to support conversations with tweens around their family's shared values and explanations for technology restrictions." - [41]*

Papers emphasize the importance of applying shared rules to parents and engaging in co-disengagement with family members rather than solely enforcing rules [22,34,43,69]. One suggestion is to allow parents and teens to collaboratively determine individual and family goals through a family interface to address tech-related tensions [16,26] and create usage patterns suitable for their family [26]. Social comparison features, such as a scoreboard displaying family members' progress, are also proposed to enhance awareness [43], while encouraging mutual support and accountability [34]. A few papers also recommend engaging in collaborative activities, such as cooperative learning or competitive games with siblings and parents [18,27,41,43]. However, it might be difficult for busy parents to participate in such activities, as these often require considerable time and effort [38].

> *"This real-time update helps family members to know each other's limiting behavior and facilitates their collaborative effort: e.g., a father recognizes that a son set a one-hour limit to allow him to study, or the son notices that his mother set a two-hour limit for family time." - [43]*

To address tensions around rule enforcement and tech use, one suggestion is to track and display factors leading to rule breaking [26]. For example, the system could record that a rule has been broken due to a sudden school commitment and show it to parents and teens. Incorporating this type of awareness aims to reduce misunderstandings and conflicts [26].

> *"[…] enable parents and teens […] to track and show situational demands that lead teens to break a pre-decided technology rule and parents to alter a restriction (e.g., teens' breaking a rule is not [to] undermine parents [personal disposition], but due to a critical message from school or friend; or parents' expecting teens to spend less time on technology as grandparents want to spend time with children during their visits)." - [26]*

5.2.4 Supporting Parents in Managing Tech Usage through Reflection and Community Guidance. Papers in our sample explore how digital interventions can support parents in managing family technology use. For instance, when parents' family tech goals are not met, leading to frustrations, Mazmanian et al. suggest a reflection tool that helps parents review and compare these goals with actual usage data to understand discrepancies and reasons for not achieving goals in different times and contexts [49].

> *"[…] parents could be randomly prompted to report how they currently feel about media use in the family while actual media use of all family members is tracked in the background. Over time, this would allow parents to reflect on how they feel about their family's media use across various times and situations by comparing this data to their family's actual usage data." - [49]*

In addition to these tools, apps could further support parents by integrating features that connect them with online communities for advice and emotional support [43]. However, social comparison with families whose lifestyles differ significantly might not be useful [43]. Hence, sharing usage information with families who have similar life patterns could provide parents with insights and strategies for effective mediation. These communities can offer guidance on regulating tech use, handling unfamiliar situations, and employing appropriate mediation strategies.

> *"Our participants also wanted to see the usage and limiting statistics of other families, hoping to determine how other families manage this issue. […] In addition to sharing simple statistics, we can help those families to form online communities for information and emotional support as in ParentNet." - [43]*

5.2.5 Reward Systems and Social Motivators to Incentivize Tech Disengagement. Several papers in our sample recommend using external motivators to encourage children to regulate their tech use [18,23,38,41,43]. A common pattern is using tangible reward systems to incentivize offline activities while reducing device time. These incentives should align with children's preferences to effectively motivate them to practice disengagement [38]. For example, Hung et al.

suggest an interactive micro-incentive system where adolescents earn points through completing small tasks to progress towards real-world rewards [38]. Similarly, Dumaru et al. propose awarding bonus screen time for completing parent-set chores [23]. Unlike other papers, they also discuss a punitive approach, where screen time is revoked if tasks are not completed, acting as a negative extrinsic motivator [23].

> *"[...] revoke or provide bonus screen time based on their compliance with the chores specified by the parents. [...] This would help to improve the aspect of instilling self-regulation by helping parents explicitly communicate about the expected behavior to the children, along with the possible outcomes." - [23]*

In addition to tangible rewards, Ko et al. propose a point-earning mechanism linked to screen time limits, where points have no material value but could promote intrinsic motivation by fostering a sense of accomplishment and personal growth [43].

> *"We used point systems in which the user can earn points proportional to the use-limiting duration. With such a point system, we expect that their intrinsic and social motivation can be increased—even though the points itself do not have any actual material value." - [43]*

Another type of external motivator emphasizes social aspects, such as involving children in use-limiting competitions with others [43], sharing accomplishments [41,43], and providing encouragement [23], which can promote a sense of accountability and achievement.

5.2.6 Diverse User and Situational Characteristics Require Customizability. Most papers stress the importance of considering individual characteristics of children and diverse family needs, highlighting several factors that influence children's technology usage and behavior regarding tech limits. These factors include age [23,27,32], gender, race and socioeconomic status [26,27], personality types, motivation levels, executive function [20], physical capability [43], and special needs [23]. For instance, in the context of smart speakers or toys, parents from higher socioeconomic backgrounds often preferred establishing non-use periods to reduce device attachment. In contrast, parents from lower socioeconomic backgrounds viewed these devices as useful aids for keeping children engaged independently, especially if the parents had to work longer hours [27].

Furthermore, when designing interventions targeting tech addiction, it is recommended to consider children's psychological state, addiction triggers, and social environment [38]. For example, when children are in an emotionally charged situation (e.g., during gaming), relying on self-control may not be sufficient. In such cases, one suggestion was for systems to infer adolescents' emotional state through sensors and tailor interventions accordingly (e.g., offering gentle reminder vs parental involvement) [38].

Several papers also recommend age-based design for parental control tools, as children's needs and self-regulation capabilities evolve over time [23,27,32,34,43,82]. Adapting the strictness of rules and the granularity of personal information disclosure based on children's age and their gradual development of self-regulation skills can help maintain sustained use [23,32,38,43].

The papers in our review describe how intervention designs should also consider the diverse characteristics of parents, including parenting styles, personal ideals, and tech competence [22,23,26,43,49]. Moreover, parents' mediation approach can further be influenced by internal disagreements and societal judgements [22] and the family's overall goals regarding tech use [26]. For instance, families valuing transparency will adopt different strategies than those preferring selective disclosure, underscoring the need for value-sensitive design [26].

> *"[...] parent's assessment of child media appropriateness can emerge from a number of contextual factors [they] likely cannot delineate in abstraction. What the line is and when it will be crossed emerges in-situ: in the context of past, present, future; in the context of internalized ideals and personal desires; in the context of broader family dynamics and a child's immediate behavior, etc." - [49]*

Papers in our sample emphasize the need to adapt rules to various contexts and situational demands [16,22,23,26,27,34,38,49]. For instance, stricter restrictions might be necessary during school periods, while rules could be relaxed during vacations [23]. Additionally, maintaining appropriate context-specific rule enforcement can be challenging for parents due to their busy lifestyles, underscoring the need for easily adjustable, dynamic settings [22].

> *"[...] parents' own principles do not necessarily fit the actual practices in the everyday life at home, whereas easily adjustable or dynamically changing settings, for example, depending on context can be helpful. Such settings could consider other factors than time at day, e.g. location." - [22]*

5.3 Relating the Identified Recommendations within an Early Adolescent-Centric Design Space

From the researcher-provided recommendations extracted from our scoping review, we identified 14 design mechanisms for supporting early adolescents' technology disengagement (summarized in Table 2). We consolidated similar recommendations across different studies into overarching "design mechanisms" that fit into the four design dimensions within an early adolescent-centric design space outlined in prior research [19] (see section 3.1). Below, we summarize these mechanisms and provide a general idea of the extent to which they align with previously identified user preferences within the design space [19] (see Fig. 1).

Recommendations from 13 out of 15 included papers relate to various ways to provide children with agency [16,18,20,22,23,26,27,34,38,41,43,69,82]. These recommendations align with both early adolescents' and their parents' preferences for solutions with at least a moderate amount of agency, as identified in prior research [19]. While two papers do not explicitly address how to facilitate agency, one notes that children's need for autonomy may evolve with age [32], and the other focuses more on parenting strategies for managing technology use [49]. We identified six design mechanisms with the potential to support ***early adolescents' agency*** that researchers recommend incorporating into intervention design. As listed in Table 2, these mechanisms include collaborative rule-setting, autonomous goal setting, self-monitoring and reflection, granular privacy controls, contextualized assistive tools, and family-wide initiatives. These approaches offer a range of different ways to empower early adolescents to self-regulate their tech use, while also considering their evolving need for autonomy and privacy.

The design mechanisms that facilitate ***supportive parental engagement*** include communication between parents and children, involvement in children's tech disengagement, and parenting support. These recommendations emphasize the importance of active supportive parental engagement, which is consistent with parents' preferences identified in prior work [19]. However, early adolescents' preferences varied—some preferred limited parental engagement, seeking more autonomy in managing their tech use, while others welcomed a certain level of support [19]. The range of design recommendations described here might address these differing preferences. For example, while mechanisms of parental involvement might not be desirable to those early adolescents who value independence, they might at least appreciate the open communication about rules and expectations.

The design mechanisms for ***mentorship*** support include parent-based mentorship, community-based mentorship, and adaptive system support. According to prior research, parents strongly preferred parental mentorship while early adolescents' preferences varied among different levels of peer support combined with parental guidance [19]. Although the majority of identified researchers' recommendations focus on parent-based mentorship, the mechanisms for community-based and adaptive system support offer more diverse ways to guide children's tech disengagement, complementing parental guidance.

Researchers recommend various design elements fostering children's ***motivation*** in tech disengagement, incorporating both intrinsic and extrinsic motivators, aligning with early adolescents' and parents' preferences identified in prior research [19]. While the papers in our

sample offer distinct mechanisms for promoting external rewards, we noticed limited discussion of the direct incorporation of intrinsic motivators. For instance, few design mechanisms enable children to choose inherently enjoyable offline activities, which can align interventions more closely with children's personal interests and motivations, rather than requiring them to complete tasks that they might not enjoy. Although not explicitly discussed, most papers do suggest mechanisms that can foster intrinsic motivation (e.g., features promoting agency and collaboration).

Table 2: Researcher-suggested design mechanisms aligned with corresponding design dimensions

Dimension	Design Mechanism	Definition
Children's Agency	Collaborative Rule-Setting [18,26,34,38,41,43,69]	involve children in negotiations and establishing common rules for all family members
	Autonomous Goal Setting [18,20,41,43]	allow children to set their own goals and tasks and provide them with choices
	Self-Monitoring and Reflection [16,20,41,43,69]	enable children to track their own usage and progress, reflect on their tech-related behaviors
	Granular Privacy Controls [23,32,38,43]	respect privacy needs by considering age and comfort levels
	Contextualized Assistive Tools [27,38]	adapt to children's needs and emotions
	Family-Wide Initiatives [27,43]	allow children to engage in tech disengagement practices with their family through collaborative monitoring and use-limiting
Supportive Parental Engagement	Communication [16,23,26,27,41,43,69]	share expectations and reasoning behind rules through messaging, reminders, and guided discussions
	Involvement [18,41,43,49,69]	promote collaboration, competitions, and shared goals, and address children's emotions by responding to their requests
	Parenting Support [16,23,26,49]	incorporate reminders and parental reflection tools for understanding family goals and deviations, nudge parents to engage in discussions, track rule-breaking factors
Mentorship	Parent-Based Mentorship [16,18,23,26,27,32,41,43,49,69,82]	incorporate parental monitoring, parent-set rules, and mechanisms for Supportive Parental Engagement discussed above
	Community-Based Mentorship [26,27,38]	provide support from family, peers, and experts, via reminders, competitions, and social learning
	Adaptive System Support [22,27,38]	offer adaptive support from digital interventions by tracking emotions, comfort, and context, and tracking family non-use behaviors to trigger nudges
Motivation	Extrinsic Motivators [23,38,43]	include parental encouragement, bonus screen time for parent-set rule compliance, competitions with scoreboards, rankings, and micro-incentives
	Intrinsic Motivators [16,18,20,23,26,27,32,34,38,41,43,69]	include agency-promoting mechanisms, features supporting open communication, collective goals, collaboration, and gamification with non-material point-based systems

6 App Analysis

To uncover the current design focus of digital interventions and identify how they support early adolescents' tech disengagement, we conduct an app analysis informed by methods utilized in previous literature [3,30,76,80,81]. Building on prior insights into the preferences of early adolescents and their parents regarding digital interventions for tech overuse [14], our analysis also assesses how well existing parental control solutions align with these preferences, highlighting areas where these solutions might not fully address the needs of our target users.

6.1 App Collection

We searched the Google Play Store and Apple App Store during May and June 2024 for apps that offer strategies to limit early adolescents' tech overuse. We used the following search keywords: 'Limit Screen Time', 'Family Screen Time App', 'Screen Time Control (kids/adolescents/teens)', 'Screen Control Kid', 'Child Screen Timer', 'Parental Control'. For the Apple App Store, we used an open-source app-store scraper [57] used by a similar study analyzing apps [48] to scrape the search results. We could not use the Google Play Store app-store scraper [58] to scrape more than 30 results, likely due to policies introduced in March 2024 that restrict machine-generated traffic [31]. Therefore, one researcher manually collected the Android apps from the Google Play Store search results for each set of keywords. From the generated app lists from both stores, two researchers manually screened the app titles, descriptions, and screenshots on each product page to verify that they met the inclusion criteria stated below.

App Inclusion Criteria – (App Selection Phase)

- The app description and screenshots include features related to limiting tech overuse (e.g., planning device time, limiting screen time, monitoring usage time).
- The app targets children/early adolescents/teens (e.g., the description/title/screenshots mention children/teens/kids). Apps targeting babies, toddlers, or only parents are excluded.
- The app has an English-language user interface.
- The app has at least 10k+ downloads (Google Play Store) or at least 5 ratings (Apple App Store).

After applying the inclusion criteria and removing duplicates, we collected a total of 88 apps (56 Android and 32 Apple).

6.2 App Evaluation

To evaluate the collected apps, we began by installing them on devices. Many apps in our sample required a companion app to support both a parent and a child profile/mode. Typically, this setup involved installing one app on a "parent device" and another on a "child device". When evaluating Google Play Store apps, we used two Android tablets (Galaxy Tab S9 FE; storage: 128 GB, android version: 14). For the App Store apps, we used an iPhone (iPhone 15 pro; storage: 128 GB, version:17.5.1) as the parent's device and an iPad (iPad Pro 3rd Gen; storage: 256 GB, version:17.2) as the child's device. After installing the 88 collected apps, we removed 25 Android apps and 16 Apple apps from our sample based on the exclusion criteria listed below. Consequently, the final app list contained 47 apps (31 Android and 16 Apple apps). This app list is included in the supplementary materials. Figure 3 outlines the app analysis workflow.

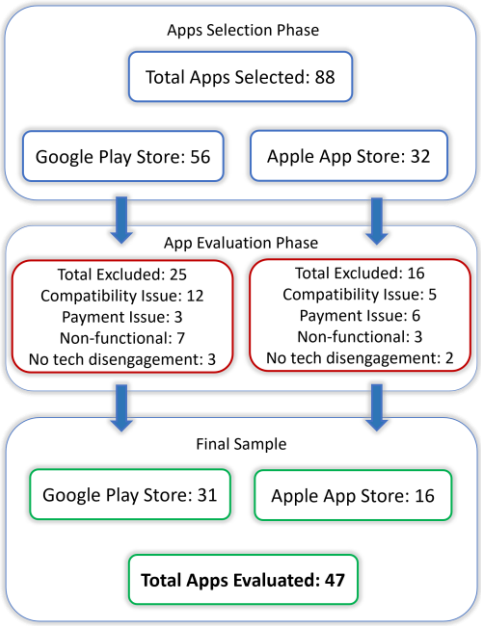

Fig. 3. App Analysis Workflow.

App Exclusion Criteria – (App Evaluation Phase)

- The app cannot be used without paying for a subscription or does not offer a free trial. If the app allows a free trial with some premium features disabled, we included it, documenting the features that could not be tested.
- The app does not function (e.g., crashes, inability to pair with the companion app), requires additional components (e.g., Xbox, router, SIM cards), requires unsafe configurations, or is incompatible with our evaluation devices.
- The app evaluation revealed no features related to tech disengagement.

Two researchers evaluated our final sample of 47 apps using a "Walkthrough Method", following Wang et al.'s approach [76]. Unlike the traditional "Cognitive Walkthrough," which targets usability issues [45], our walkthrough focused on identifying features related to tech disengagement. Both researchers explored all apps together as potential new users, playing a specific role (i.e., a parent or an early adolescent user), while trying out all available features. They shared their observations and independently listed and described all features of each app. If the app allowed users to select an age-based restriction mode, we chose the age group that aligns with our target audience of 11-14 years. In cases where multiple supervision modes were available (e.g., monitor only, monitor and show warnings, monitor and manage), we chose those with the most parental restrictions, as these modes typically provided the most comprehensive access to the range of features offered by the apps.

6.2.1 Identifying Distinct Features and Generating a Codebook. From the descriptions of all features explored in the collected apps, one researcher independently used a bottom-up approach to identify and categorize features related to limiting children's tech overuse, distinguishing between parent and child features. This researcher initially coded the distinct parent and child features based on the descriptions documented during the app evaluation, grouping similar features under higher-level codes (e.g., "MESSAGING" in Fig. 4). These coded features were

Feature Category: Communication & Negotiation				
Children's Feature Sub-Categories	Feature ID	Final Codes	Initial Coding of Individual Features	Individual Features Identified
Requesting for Rule Changes/ Extensions	EF6	REQ-CUST-MSG	REQ-CUST-MSG	Send custom message for the request
	EF7	REQ-OFFLINE-NEGOTIATE	REQ-OFFLINE-NEGOTIATE	Prompts children to ask in-person if the request is denied/limit exceeded
	EF8	MODE-CHANGE-REQ	MODE-CHANGE-REQ	Request for changing the mode of restriction/changing a rule
	EF9	CONTENT-ACCESS-REQ	CONTENT-ACCESS-REQ	Request for accessing a blocked app/site
Messaging	EF10	MESSAGING	IN-APP-CHAT	Send and receive messages
			IN-APP-FAMILY-CHAT	Group messenger with family if multiple devices are connected
			IN-APP-CHAT-PROMPTS	There are stickers and prompts as well to facilitate communication
			AUDIO-MSG	Can record audio message and send to the parent
	EF11	MESSAGING-RCV-ONLY	IN-APP-CHAT-ONLY-RCV	Cannot send messages, only receive messages from parents

Fig. 4. A snippet from our codebook that includes sub-categories of children's features under the feature category "Communication/Support".

documented in a codebook along with descriptions of the codes (the complete codebook is included in the supplementary materials, see Fig. 4 for a snippet). The researcher then clustered the codes into different feature categories. A second researcher, who also participated in the app evaluation, crosschecked the codebook against their own observations to ensure completeness. The codebook was collaboratively refined by both researchers, and a summary of the feature categories and key findings is provided in section 7.1.

6.2.2 Mapping the Apps to the Design Dimensions. Using the independently documented app feature descriptions from the app evaluations, two researchers collaborated to identify and code all features for each app based on the predefined codebook discussed above. They then mapped the apps onto the four key design dimensions for early adolescents' tech disengagement (see section 3.1) [19]. Using the app feature descriptions and the definitions of the coded features from our codebook, each researcher independently rated each of the 47 apps on these dimensions within a range of low, low-medium, medium, medium-high, and high, according to the guidelines presented in Table 3. They subsequently cross-checked their mappings, resolving any disagreements through discussion. Despite using a 5-point scale, many apps are not precisely located at these discrete points but rather fall within a range around these points. We placed each app at the closest point for clarity, discretizing the dimensions for our app mapping, following the approach taken in the original study [19] (see section 3.1). Our goal with this mapping exercise was to identify the current focus areas within the design space, rather than to pinpoint the relative positioning of each app. This broader level of granularity also facilitated a more productive conflict resolution and discussions compared to a more granular approach. Findings from this analysis can be found in section 7.2.

7 App Analysis Findings

7.1 Categories of Feature Identified

From our app analysis, we identified 6 categories of features, which are listed in Table 4, along with the key features identified within each category. In total, we identified 64 features - 34 child features and 30 parental features. Some features appeared in both groups (e.g., both parent and child can monitor daily device usage). Below we discuss each of the 6 categories of features identified from this app analysis.

Content Restriction: To limit overall technology use, parents often restrict children's access to digital devices, online media, or certain applications (e.g., games) [10], a strategy that was also prominent in our app analysis. The most common content-restriction feature, found in 40/47 apps, enables parents to control their children's access to all or specific apps. Restrictions are typically enforced by blacklisting or hiding apps, where most parental control apps simply block access without showing any notice to the child, demonstrating a lack of transparency and awareness of

the parent-set restrictions for the child. Additionally, 29/47 apps allow parents to block their children's devices at any time, making the device inactive, except for parent-set whitelisted apps. Although these blocking features can limit children's tech use, they emphasize enforcing parental control over promoting children's self-regulation.

Table 3. Guidelines for mapping features to design dimensions

Dimension Ranges	Guidelines for Mapping
Level of Children's Agency	
low	absolutely no say for children - parents decide everything (e.g., set rules/block apps)
low-mid	children can negotiate but parents have the final say (e.g., request extra time and track own usage/select tasks from the parent-created list)
mid	both have equal say regarding the disengagement process (e.g., decide rules together and both can track)
mid-high	some features where the children have the final say, parents can negotiate (e.g., stop supervision)
high	children decide everything (e.g., setting their own limits and tracking usage)
Level of Supportive Parental Engagement	
low	no option for parents to communicate/address children's emotions via the app
low-mid	some features to address children's requests/emotions (e.g., respond to requests/administer rewards)
mid	good level of communication from parents (e.g., in-app chatting, sharing reasonings)
mid-high	some features for parents to practice co-disengagement (e.g., competitions, joint tasks)
high	co-practicing disengagement with the child (e.g., same rules for both)
Type of Motivation	
only intrinsic	many features that promote decision-making, self-monitoring, planning inherently enjoyable offline tasks
more focus on intrinsic than extrinsic	most features are intrinsic (e.g., self-monitoring and choosing tasks, planning), along with some external rewards/motivation/pressure
combination	a combination that equally balances both types of motivation (e.g., choosing your own tasks with rewards)
more focus on extrinsic than intrinsic	a few features are intrinsic, mostly external rewards/motivation/pressure
extrinsic	only external rewards/motivation/encouragement/competition/external pressure
Type of Mentorship	
only parental	no peer support or guidance (e.g., only parental restrictions and guidance)
parental with some peer-based mentorship	mostly parental guidance with some support from peers/peer-like character (e.g., messaging/reminders)
combination of peer-based and parental	peer-based mentorship from a virtual character with peer-like characteristics, along with equal level of parental guidance and supervision
peer-based with some parental mentorship	mostly peer guidance with some parental support (e.g., messaging/reminders)
peers only	no parental support or guidance (e.g., peer-set restrictions and guidance)

Table 4. Summarizing key findings for parental and child features across different feature categories

Feature Categories	Parental Features	Child Features
Content Restriction	40/47 apps allow parents to block all or specific apps 29/47 apps allow parent-triggered device blocking	40/47 apps restrict from accessing blacklisted apps 10/47 apps display default notices or blocked screens when trying to access restricted devices/content
Time Restriction	28/47 apps set a time limit for overall device use 21/47 apps set a limit for specific apps 20/47 apps allow limit adjustments	In 39/47 apps, time limits are applied without input from children 19/47 apps allow children to request extra time
Planning Screentime	27/47 apps allow scheduling of device time 23/47 apps allow scheduling of downtime Can set offline tasks for downtime in 8/47 apps	3/47 apps allow children to select their own tasks
Reinforcements	Decide the ratio of earned points/screentime awarded for learning or task completion in 13/47 apps Review evidence of task completion before awarding points or screen time in 5/47 apps Engage in competition with children in 1/47 apps	Earn points/rewards for completing tasks in 5/47 apps Earn screen time in 8/47 apps for offline tasks or learning activities Submit evidence of task completion in 5/47 apps Engage in competition with parents or peers in 1/47 apps
Monitoring Usage and Progress	39/47 apps track device or app usage (e.g., daily, weekly, monthly, custom dates) Can stop monitoring in 6/47 apps	13/47 apps allow children to monitor their own usage 6/47 apps allow progress tracking for learning or tasks 11/47 apps display timers for children 4/47 apps provide warnings before time outs 9/47 apps make rules visible to children 3/47 apps allow children to stop parental monitoring
Communication and Negotiation	5/47 apps allow custom responses to children's requests 6/47 apps include in-app messaging for parent-child communication 3/47 apps support one-way messaging from parents Can set reminders for children in 4/47 apps	19/47 apps allow children to request changes to rules 5/47 apps let children send custom messages 3/47 apps encourage offline negotiation with parents 6/47 apps support in-app chatting, with a few allowing voice messages and stickers

Time Restriction: Limiting time is the second most common feature found in 39 out of the 47 apps analyzed. Time limits are typically applied on overall device use or on specific apps. When the time limit is exceeded, the parental control app will block all or specific apps or lock the

device. Parents can set different limits for individual days or apply the same limit every day, with possible exceptions on weekends. While 20/47 apps offer flexibility in adjusting limits, they do so without involving children in the initial decision-making process.

***Planning Screentime*:** Of the 47 apps surveyed, 34 included scheduling features that allow parents to plan children's device time (27/47) or downtime (23/47). Planning device time involves specifying periods for device use and selecting apps for each period (e.g., apps for study or entertainment). Scheduling downtime involves creating offline routines (e.g., bedtime, homework) and setting offline tasks (e.g., chores, challenges), during which the device is paused with all apps blocked. Typically, offline tasks are selected by parents, with only 3/47 apps allowing children to choose their own tasks. These scheduling features focus on helping parents manage and structure their children's tech use, like the features discussed above, rather than involving children in setting their own schedules.

Reinforcements: We found that the use of positive reinforcement strategies in these apps is generally limited. 13/47 apps incorporate gamification techniques by offering points, real rewards, or screen time for spending screen-free time and completing offline tasks or learning activities. Among these, 5/47 apps require children to submit evidence of task completion for parental review before rewarding, reinforcing parental control rather than encouraging children to take ownership of their behavior. Only one app involves children in competition with parents or peers to encourage other activities. Overall, the limited use of positive reinforcements relies mainly on external rewards, without fostering intrinsic motivation, which is important for developing self-regulation skills [67].

Monitoring Usage and Progress: Most parental control apps (39/47) enable parents to track their children's overall device usage or individual app usage, over different periods of time. However, only 13/47 allow children to monitor their own screen or app usage. Additionally, while all these apps employ many parent-set restrictions, only 9/47 make these rules visible to children. This indicates a gap in transparency and self-monitoring opportunities for children, which could affect their ability to practice tech disengagement independently and understand the parent-set boundaries enforced by the apps.

Communication and Negotiation: Among the 47 apps, 19 allow children to request rule changes, such as extending time limits, accessing restricted content, or changing the mode of restriction, which parents can approve or deny. Additionally, 3/47 apps encourage offline negotiation by asking children to discuss their opinions about the rules with their parents, and only "Boomerang Parental Control" prompts parents to seek more information from their children before accepting or rejecting a request. Although limited, these apps allow children to let their voices be heard and adjust rules accordingly through negotiation. In terms of communication, 6/47 apps have in-app messaging features that allow both parents and children to communicate. However, 3/47 apps support only one-way messaging from parents where children cannot reply. Overall, this highlights a general lack of interactive and supportive two-way communication features, which could limit effective parent-child dialogue and negotiation.

7.2 Mapping Apps onto Design Dimensions

To highlight areas of focus and identify whether current parental control apps address the needs and expectations of our target users, we map these apps onto an early adolescent-centric design space [19], following the method in section 6.2.2. We present our findings by illustrating the distribution of 47 apps across four design dimensions (see Fig. 5) and providing examples from our analysis. Each graph is overlaid with the ovals from Figure 1, representing the preferences of parents (red) and early adolescents (blue) as identified in prior work [19] (see section 3.1). These ovals highlight the ranges of user preferences, offering a visual comparison against the app mappings.

7.2.1 *Level of Early Adolescents' Agency.* According to the design space study discussed in section 3.1, early adolescents expressed a preference for mid to high levels of agency in practicing

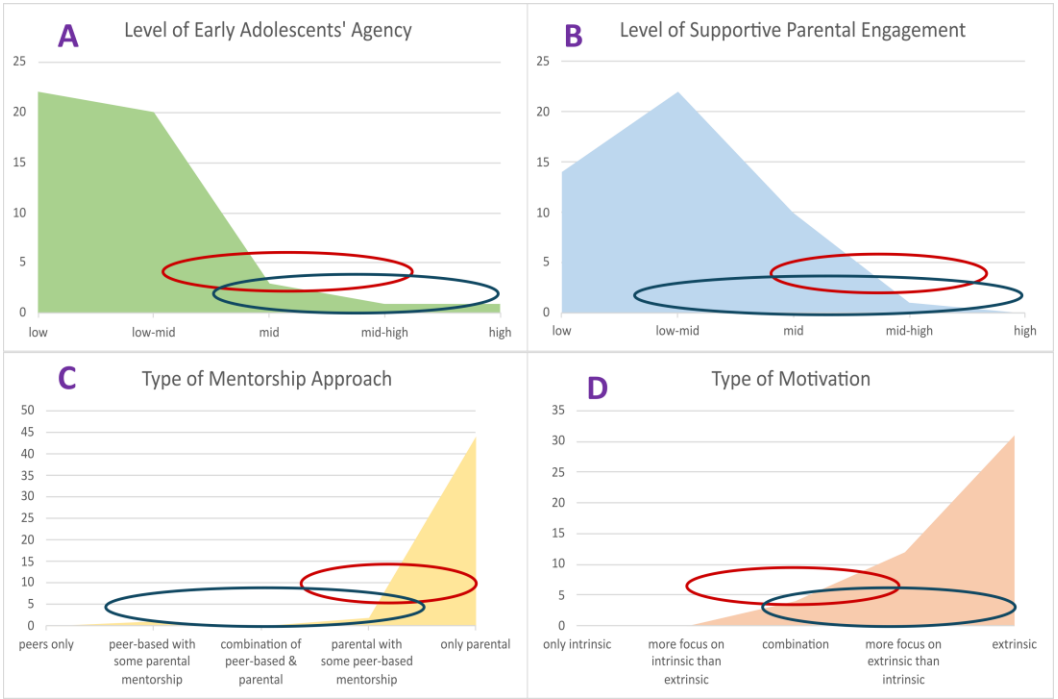

Fig. 5. The area graphs show (A) agency levels, (B) supportive parental engagement levels, (C) mentorship types, and (D) motivation types for 47 parental control apps on a 5-point scale. The X- and Y-axes in each graph represent the dimension ranges (defined in Table 3) and number of apps, respectively. Blue and red ovals indicate early adolescents' and parents' preferences across the dimensions, respectively, as identified in [19].

tech disengagement [19]. Parents' preferences were also in the mid-range, leaning towards the higher levels. However, we found that most parental control apps in our sample fall in the low (22/47) and low-mid (20/47) ranges (see Fig. 5A). For instance, "Kids App Lock: Parental Lock" provides low agency which restricts app access and enforces device blocking without involving children in rule-setting, usage tracking, or negotiation. An example of an app with a low-mid agency is "CALMEAN Control Center". Although it does not involve children in initial rule-setting and parents have the final say, it enables them to negotiate time limit-related rules by sending requests to parents. Here, children can also monitor their app usage, view rules, and track remaining device time.

Only 3/47 apps had a medium level of agency. For example, "Find my kids: Parental Control" and "FamiOn: GPS Location Tracker" empower children to disable parental supervision and negotiate with parents. The "Kid Security: family locator" companion app also enables them to stop parental monitoring, choose offline tasks, and track their progress. We found just one app in the mid-high range and one in the high range of agency. "Google Family Link" was mapped to the mid-high range as it empowers children to disable all parent-set restrictions and negotiate rule changes by sending requests. If they choose to disable parental rules, this app warns them that it will restrict device access for 24 hours, after which they can use it without restrictions. While offering time to reconsider their decision before acting impulsively, it also serves as a disincentive by temporarily removing access. The only app with a high-level agency was "Trumsy", which does not enforce parental restrictions. In this app, the children can choose their offline tasks and challenges, co-practice tech disengagement with their parents, and track their progress.

7.2.2 *Level of Supportive Parental Engagement.* The design space study showed that parents preferred mid to high levels of supportive engagement, while early adolescents had varied preferences [19]. Our mapping placed most apps in the low (14/47) to low-mid (22/47) ranges (see Fig. 5B). Apps with low parental engagement do not incorporate any features for parent-child communication or address children's emotions (e.g., Family Space). Apps in the low-mid range include some features addressing children's feelings, such as letting parents respond to children's rule-change requests, setting reminders, and administering rewards to foster positive emotions towards tech disengagement (e.g., "kids360: Parental Control").

According to our rating, 10/47 apps had a medium level of supportive parental engagement, like "Boomerang Parental Control", which includes in-app chatting to support communication between parents and children. Along with responding to children's negotiation requests, it also allows parents to share their reasoning behind restrictions while inviting children to justify their rule-change requests. We rated only one app, "Trumsy" as having a mid-high level of parental engagement. It allows parents to co-practice tech disengagement as a form of competition and motivates children by administering rewards. We did not find any apps with high parental engagement in that the apps actively involve parents in tech disengagement with their children on a regular basis.

7.2.3 *Type of Mentorship.* Most of the apps in our sample (44/47) employ parental mentorship (see Fig. 5C), reflecting parents' preferences identified in the prior study [19]. Only two apps included some elements of peer or peer-like support alongside parental mentorship. For example, "Trumsy" allows children to compete with peers by completing challenges, while "Safe Lagoon" integrates an AI Bot that reminds children about rules through chat interactions. We found only one app, "Taki - your screen time friend", that employs a balanced combination of a peer-based approach and parental mentorship. It uses a friendly virtual character to foster children's self-regulation which interacts with children as a peer through dialogues and gestures and provides distractions to smoothly end screen time before the time limit is reached. While parents do not actively mentor children through this app, they are responsible for setting time limits and tracking usage. We did not find any app relying solely on peer-based guidance. Although the design space study [19] did not indicate a strong inclination for a purely peer-based approach, many early adolescents did express a desire to include peer support to some extent alongside parental guidance.

7.2.4 *Type of Motivation.* According to the design space study, both parents and early adolescents preferred a combination of intrinsic and extrinsic motivation, with early adolescents showing a greater inclination towards extrinsic motivation, particularly positive reinforcements for tech disengagement [19]. Our findings reveal that 31/47 apps rely solely on extrinsic motivation with only 12 incorporating elements of intrinsic motivation (see Fig. 5D). Moreover, most apps in our sample (30/47) utilize only restrictive measures, such as device blocking, rather than encouraging voluntary engagement through positive reinforcement. These restrictive features can act as external pressure to comply with rules, as non-compliance can result in negative outcomes (e.g., no device access). Only 13/47 apps include positive extrinsic motivation alongside rule enforcement, typically offering rewards for following parent-set instructions, such as completing offline tasks. For instance, "Screen Time Parental Control" rewards children with additional screen time for completing parent-selected offline activities. An example app that includes some intrinsic motivation with external rewards and pressure is "FamiOn: GPS Location Tracker". This app motivates offline activities with reward points, which can be redeemed for real rewards (e.g., toys) from child-created wish lists. It also fosters some intrinsic motivation by allowing children to select tasks from a parent-set list and offering social support through messaging features.

Only four apps in our sample demonstrated a balanced combination of intrinsic and extrinsic motivation. For example, "Kid Security: family locator" incorporates both rules and rewards as extrinsic motivators while fostering intrinsic motivation through self-monitoring and enabling

children to choose inherently enjoyable offline tasks. Although "Google Family Link" primarily relies on external pressure through parental restrictions, it also supports intrinsic motivation by allowing children some control over their tech regulation. For instance, the app empowers them to disable parental restrictions and self-monitor their usage. Our sample did not include an app that prioritizes intrinsic motivation alone due to the prevalent use of parent-enforced rules that act as external pressure.

8 Discussion

8.1 Research Trends and App Focus for Digital Interventions Targeting Tech Overuse

Our findings provide insights into current research and applied trends addressing children's tech overuse via digital interventions aimed at promoting tech disengagement. Our systematic scoping review highlights key researcher recommendations for designing such interventions. For example, researchers emphasized the importance of involving children in rule-setting and self-monitoring, respecting their privacy, promoting family collaboration and communication, and utilizing reward systems and social motivators to incentivize tech disengagement practices. Additionally, researchers recommended incorporating tools to support parents in managing children's tech use and suggested ways to design for users' diverse needs and situational demands. Our scoping review also presents a set of 14 curated design mechanisms that future digital interventions targeting early adolescents should consider incorporating.

Findings from the app analysis reveal the current design focus for digital interventions, identifying six primary categories of features, including time and content restrictions, planning screentime, reinforcements, and communication. However, we observed that most apps have features that are parent-focused, aligning with prior findings on apps promoting online safety [29,81]. Our analysis confirms that these design issues extend beyond safety-focused interventions, applying also to tech disengagement apps. This generalization to apps with a different objective highlights the need for designing digital interventions that address the requirements of both early adolescents and their parents.

Despite employing search queries that identified over 1300 abstracts, our scoping review identified only 15 relevant articles, with just 6 focusing on prototype design for tech disengagement, only 4 of which included user evaluation. A similar lack of user-centered research was observed in prior reviews, for example, a review on parental control tools for children's online safety found only 7 studies involving end users in the design or evaluation process [39]. This indicates a relatively open research space, with opportunities for future work to explore more user-centered approaches in developing tech disengagement interventions for early adolescents.

Our scoping review indicates only limited research specifically targeting early adolescents (11-14 years). Most papers focused on a broader age range, making it difficult to fully pinpoint guidelines specifically tailored to this age group. Since each developmental stage has unique requirements, different ages likely require different forms of support for regulatory activities like managing tech use. For example, while appropriate for early adolescents, the autonomy granting design mechanisms presented in Table 2 might not benefit younger children, as they may not yet be matured enough to make informed decisions. More age-specific research efforts are needed to ensure that digital interventions cater to the unique needs of different age groups.

We used an initial early adolescent-centric design space, defined in prior literature [19], as a tool for further analysis. During our use of the design space to analyze current apps, we identified some nuances that existing dimensions might not fully articulate. For instance, while the design dimension "mentorship approaches" currently covers a spectrum between parental and peer-based mentorship [19], researchers also recommend community-based mentoring from experts and other families with similar lifestyles. Future research should further refine this design space

by incorporating additional dimensions that explore these types of complex aspects of tech disengagement. Investigating the multidimensional relationships within an expanded design space could lead to more innovative, user-centered solutions that address the unique needs of target demographics.

8.2 Connecting Researchers' Recommendations to App Design: Implications for Design

Promote Children's Agency Through Empowering Features. Our findings from both the scoping review and the app analysis revealed a noticeable gap between the design elements researchers recommend and those commonly implemented in existing apps. For example, most of our included papers highlight the importance of granting children a sense of agency through mechanisms like collaborative rule-setting, autonomous goal-setting, and self-monitoring. However, most parental control apps focus primarily on restricting children's access to technology without involving them in decision-making processes. This suggests a lack of apps that encourage children to develop self-regulation skills through greater autonomy, reflecting a need for app developers to adopt more empowering features in their designs.

Facilitate Parent-Child Communication and Collaboration. Our scoping review found that researchers emphasize the importance of fostering communication and collaboration between parents and children in managing tech disengagement. Despite these recommendations, our app analysis identified only a few parental control apps that integrate features for parent-child communication and support, which is critical for negotiating device usage rules and ensuring fairness in their enforcement. This gap highlights an opportunity for app developers to design features that promote open discussions and co-practice of digital boundaries between parents and early adolescents.

Expand Mentorship Beyond Parental Guidance. Researchers' recommendations on mentorship, especially parent-based mentorship, are reflected in most apps, with nearly all utilizing some form of parental guidance. However, our findings from the scoping review also highlight the potential benefits of broader mentorship approaches, such as community-based or peer-based systems, which were largely absent from the apps reviewed. Since some early adolescents prefer a combination of peer and parental support [19], there is an opportunity to design more dynamic mentorship systems integrating options for early adolescents to seek guidance from a wider range of sources, which could better align with their developmental needs.

Incorporate Positive and Intrinsic Motivators. Our review identified a range of recommendations for providing positive extrinsic motivation in tech disengagement interventions, with a focus on strategies such as rewards and reinforcements. Although most of the reviewed papers did not explicitly discuss intrinsic motivation, they emphasized the importance of promoting agency and collaboration, which fosters intrinsic motivation. Despite these recommendations, most parental control apps in our sample rely heavily on negative extrinsic motivation, particularly through restrictive measures such as device blocking or time limits. While some apps do incorporate positive reinforcement, only a few foster intrinsic motivation by offering children control over choosing enjoyable offline activities or self-monitoring. Prior research suggests that simply pressuring early adolescents to follow rules may not effectively motivate them to practice tech disengagement [19].

Enable Customizability Based on User Characteristics. Researchers also suggest incorporating customizable features that adapt to users' diverse characteristics, such as age, gender, personality, and level of tech addiction. We found only 10 apps that allowed parents to change their modes of supervision, providing the flexibility to select a more appropriate mediation strategy for their early adolescents. Furthermore, as discussed in 7.2.1, only a few apps allow children to change their level of control by turning off parental supervision. Although some apps offer adjustable time limits and screen-time planning based on specific contexts (e.g., school hours, vacation), most do not involve children in these decisions, undermining their autonomy.

These findings emphasize the importance of developing digital interventions that offer customizability for both parents and children, empowering them to tailor features to their individual needs and situations to foster a more personalized and sustainable approach to tech disengagement.

Bridge the Gap Between Research and Practice Through Sustainable Child-Oriented Interventions. Our review revealed that prior research promotes autonomy granting and motivational mechanisms alongside supportive parental engagement and guidance. However, most existing apps continue to emphasize restrictive parental control, and few studies explore functional prototypes that instantiate these recommendations or assess their practical impact. HCI and CSCW researchers and practitioners can address these gaps by examining real-world application of these recommendations and developing parent-child collaborative technologies that balance autonomy and control, while mitigating trust issues and conflict. To determine the sustainability of the design mechanisms and their impact on tech usage patterns, more longitudinal studies are required, as most papers in our sample involve only short-term evaluations (e.g., 2-3 weeks).

8.3 Social Factors Shaping Design Recommendations

Through our review, we observed several social factors influencing the use and perception of interventions, shaping the design recommendations. These include parent-child trust and conflict, emotional dynamics, and cultural norms. For instance, while intrusive monitoring can raise parental awareness, it may compromise trust and autonomy, especially for older children, leading to parent-child disagreements. Designers should promote mutual trust while respecting privacy though abstracted personal information disclosure, joint reflective activities, and consent-based privacy agreements. Emotional factors also shape recommendations; for example, imposing restrictions without proper reasoning can undermine autonomy and cause resentment, while unclear communication about rules can create misunderstandings. To support emotional wellbeing, interventions should encourage shared decision-making, open communication, and sharing of contextual factors impacting rule compliance. Additionally, cultural norms often impact parenting and mediation strategies, as families from different backgrounds may have diverse views on appropriate tech use, autonomy granting, and reward mechanisms.

The design recommendations across varied user needs and social factors suggest that HCI researchers should consider their relationships and applicability. For instance, autonomy-granting mechanisms and intrinsic motivators can complement each other, while integrating parental and community-based mentorship may depend on family preferences. Further research is needed to explore how to present multiple features effectively without overwhelming users, and to better understand real-world trade-offs.

8.4 Limitations and Future Work

While our systematic scoping review initially identified 1386 papers from two relevant databases (ACM and IEEE), only 15 papers met our inclusion criteria in the final sample. One possible explanation could be the design of our search query, which may have unintentionally narrowed the results or led to an overrepresentation of less relevant papers. For example, we included some intervention-related terms in our search query (e.g., intervene, regulate, reduce), which might overlook papers that do not use these terms but describe similar concepts using different language, like “prevention” or “balanced tech usage”. Conversely, some of these terms, such as “regulate”, could have introduced noise by retrieving papers that discuss regulation in other contexts (e.g., emotion regulation). To improve the signal-to-noise ratio, future studies might refine the query by experimenting with more precise or alternative search terms. For instance, one complementary approach to fostering healthy tech habits is to promote purposeful technology use, by encouraging children to have positive and specific intentions to mindfully

engage with technology [33,40]. Future work could include this literature to offer a broader perspective.

Our scoping review considered two databases (ACM and IEEE) within a timespan of 10 years. While this approach was informed by similar reviews [77,78], it may have restricted the size of our final sample. Expanding the search to include databases from fields like psychology, education, and child development, along with additional platforms like Taylor & Francis, Elsevier, DBLP, and Google Scholar, could provide different perspectives.

Our app search strategy resulted in a sample primarily consisting of parental control apps. As a result, our analysis did not cover general-purpose everyday apps, such as social media or gaming apps, which might incorporate features to support disengagement. We also excluded apps that required paid subscriptions without offering any free trials, consistent with a prior study analyzing parental control apps for online safety [81]. This decision may have left out some widely used apps from our final sample, however, given that there were only 9 such apps in our initial sample, it is unlikely that including these apps would drastically shift our overall findings.

We used early adolescents' and parents' preferences identified in a prior study [19] to explore how aspects of our scoping review and app analysis align with this demographic. Although, to our knowledge, this is the only study that specifically elicited design feedback from early adolescents on disengagement from tech overuse, the study was conducted with a relatively small sample (13 pairs of early adolescents and their parents). Future work could conduct a broader study to validate those prior findings. A broader dataset might reveal different design preferences, which could impact the generalizability of some of our findings.

While relating the identified recommendations with the design space dimensions defined in the prior study [19] (section 5.3), we observed overlap among dimensions. For instance, design recommendations related to supportive parental engagement may align with parent-based mentorship, and agency-supporting mechanisms can contribute to intrinsic motivation. Future research should further refine the design space by investigating the multidimensional relationships among these aspects.

When mapping the apps onto the early adolescent-centric design space, we used a 5-point scale to rate and position the apps on various design dimensions. While this broad classification facilitated a comparative overview and helped app evaluators to identify key focus areas, not all apps fit neatly into these discrete points. This lack of precision could result in some loss of detail, particularly with complex features. For example, an app may offer varying degrees of agency, but the extent and quality of this agency could vary across contexts, which may not be fully captured in the scale. Future research could explore more nuanced mapping techniques to better capture these complexities.

9 Conclusions

In this paper, we present a comprehensive analysis of the current landscape of digital solutions aimed at early adolescents' tech disengagement. Our exploration highlights significant research trends and app design focus areas, revealing critical gaps in how existing interventions meet the expressed needs of early adolescents and their parents. Our findings also reveal a lack of design-oriented research that specifically targets this age group. The insights gained from our systematic scoping review and app analysis offer important design implications for developing solutions that support early adolescents in limiting their technology overuse. These findings can be leveraged by HCI researchers and practitioners to ground future explorations of digital interventions that promote healthy tech use among early adolescents.

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