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Posted Date: 22 May 2026

doi: 10.20944/preprints202605.1490.v1

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Sentiment Changes During Anonymous, On-Demand, Real-Time Moderated Digital Peer Support Among Government Plan-Sponsored Adolescents and Young Adults: A Retrospective Observational Study

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Abstract

Background. Adolescents from low socioeconomic status households experience increased emotional distress and barriers to mental health care. Real-time moderated digital peer support (DPS) offers an evidence-based, scalable, and low-barrier complement to formal support. **Objectives**. This study focused on state-level sentiment changes among government plan-sponsored adolescents and young adults who accessed a no-cost, 24/7, anonymous, real-time moderated DPS service. **Methods**. Retrospective analysis contained 1,005 moderated live chats between March and December 2024 from 663 users aged 13-20. Sentiments were scored using a few-shot learning approach with GPT-4o-mini, evaluating sadness, stress, insecurity, loneliness, anger, anxiety, and optimism. Sentiment trajectories were mapped as conversations progressed and assessed using Wilcoxon signed-rank tests and effect sizes. **Results**. Significant improvements were observed in all sentiments throughout the conversations (all $P < 0.001$), with the greatest reductions seen for anger (46.94%, r=0.87), loneliness (31.99%, r = 0.79), and stress (31.02%, r = 0.82). Smaller but also significant reductions in anxiety (29.81%, r = 0.79), sadness (28.64%, r = 0.81), and insecurity (24.71%, r = 0.75) were observed, with a substantial improvement in optimism (47.69%, r = 0.70). **Conclusions**. Among government plan-sponsored adolescents and young adults, use of anonymous, real-time moderated DPS was associated with reduced negative sentiment and increased optimism expression. Given the higher burden of mental health concerns and barriers in this population, DPS may serve as a scalable approach to expand access to emotional support.

Keywords: low-income households; adolescent mental health; government-sponsored health plans; socioeconomic status; digital peer support

1. Introduction

1.1. Background

It is widely accepted that there is a direct and causal inverse association between low socioeconomic status (SES) and health for chronic and mental health conditions [1,2]. Individuals from low-income households have greater exposure to chronic stressors such as food insecurity, lack of stable housing, as well as environmental stressors, such as substance use and violence. Adolescents living in these households cannot avoid exposure to familial stressors, and their effects may persist across generations.

Overall, U.S. adolescents report increasingly more psychological and behavioral conditions such as subclinical anxiety and depression, inattention, and hyperactivity [3,4]. Indicators of emotional

 doi:10.20944/preprints202605.1490.v1

distress, such as feeling sad, worried, bored, or frustrated, also increased. Across studies of diverse global adolescent populations, there are consistently high levels of psycho-emotional disturbance, especially stress, sadness, and loneliness. Loneliness is on the rise among adolescents both in the U.S. and globally, and is correlated with greater use of the internet, mobile phones, and social media [5,6]. Emotional distress levels are disproportionately higher among lower-income adolescents [7]. This correlates with extensive evidence demonstrating that mental health challenges increase as SES decreases [8]. Further adding to the burden of factors that contribute to emotional distress, poverty is also linked to an increased risk of obesity and behavioral issues, and reduced vocabulary and reading skills [9,10].

In addition to emotional distress, a mental health crisis among low-income adolescents exists. Youth from low SES households are estimated to have a two- to threefold higher risk of developing a mental health condition compared to their peers from higher SES backgrounds [8,11]. The prevalence of mental health conditions is estimated at 21% within this group and may reach as high as 50% among youth receiving welfare [12], compared with approximately 13-20% of teens worldwide [13–15]. More recent studies showed that rates of depression and suicidal ideation (SI) in teens from all SES are on the rise [16].

The rising rates of emotional distress may be partly explained by social baseline theory [17]. This theory states that humans rely on social support to perceive their environment as less threatening [17]. When social support is available, emotions become less distressing and perceived threats are reduced. Conversely, when social support is limited or missing, perceived threat increases [17]. Consistent with social baseline theory, direct access to social support may help reduce emotional distress. However, adolescents face a myriad of barriers to obtaining appropriate mental health care when needed, with these barriers disproportionately affecting those from lower SES backgrounds. It is estimated that more than half of children aged 17 years and younger with a diagnosed mental health condition do not receive treatment [18], due to barriers such as mental health stigma, unsupportive family belief systems, low mental health literacy, and difficulty accessing services [19]. Access to treatment is even lower among teens from low SES households [11], reaching as high as 85% among youth receiving welfare [12].

Given these barriers to care, there is a critical need for alternative approaches to address the mental health needs of adolescents, especially those from lower-income households. Access to care is often conceptualized using the framework introduced in 1981 by Pechansky and Thomas, which characterizes access to care as a multidimensional construct including five domains (known as the 5 A's): availability, accessibility, accommodation, affordability and acceptability [20]. Given the large volume of teens facing inadequate access to mental health care and emotional support, solutions are needed to address every dimension of access and span varying levels of illness severity, from subclinical emotional distress to severe mental illness.

Availability, defined as the relationship between the supply of care and the level of need, and accessibility, traditionally defined as the geographic distance between where a patient lives and where care is provided [21], are two access variables that may be improved through effective health interventions at the population-level. Such solutions are especially helpful in reaching groups at elevated risk and offer opportunities to deliver broad-based support to adolescents experiencing emotional distress or increasing vulnerability to mental illness. These approaches can also benefit adolescents with untreated conditions, as not all are ready or willing to engage in typical mental health care but may be receptive to complementary support that can serve as bridges to formal care services. In addition, resources may help to identify emotional distress early before it advances to clinical mental illness.

Adolescence is a developmental period characterized by heightened emotional expression, often in response to developing independence and hormonal changes. It is also associated with a heightened focus on forming and managing social relationships. The nature of adolescents' social connections is also shifting from primarily in-person to mostly digital interactions, or a mix of both [22]. All of these changes result in an expected and healthy expression of negative emotions, including

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sadness, anxiety, anger, and insecurity [23]. Stress, which can be both positive or negative, is also a normal component of adolescent development as teens learn to navigate their responsibilities and increasingly independent lives [24]. Feelings of loneliness may arise from real or perceived deficits in social relationships and connectedness [22]. In addition to negative emotions, optimism is an important protective emotional state during adolescence. It is closely related to resilience, increased coping skills, and robust emotional regulation [25]. All of these emotions, when transient and supported by effective emotional regulation, are developmentally normal and expected in adolescence. However, when one or more emotional states become persistent, heightened, or insufficiently regulated, this can be an early sign for greater concern [26]. Other factors such as trauma, bullying, or violence further increase teens' vulnerability to downstream physical and mental health conditions [27].

With this in mind, we aimed to introduce and evaluate an alternative intervention for low-income teens experiencing increased emotional distress who may not yet meet clinical criteria for a mental health condition. This study examines the role of a DPS intervention in reducing emotional distress and increasing access to emotional health support and resources for teens with subsidized government plans.

1.2. Peer Support

Peer support interventions are defined as solutions which bring individuals facing similar struggles or conditions together to create an environment of mutual support [28], offering opportunities for connection and building empathy around shared life experiences. Peer support can take many forms, such as groups that meet in-person or virtually. Conversations can be structured or more free flowing, and groups can be led formally by trained moderators or informally by group members [29]. In contrast to receiving mental health treatment delivered by trained professionals, peer support is a different and often more accessible approach that provides an opportunity for connection, validation, and empathy around the shared lived experience. This shared experience is key to forming meaningful connections and fostering emotional healing.

Though the extent of the impact of peer support has not been consistently established given the wide variation in delivery modalities, evidence indicates positive benefits on individuals with formal mental health diagnoses [30,31]. For example, a study of individuals with severe mental illness found that peer support increased life satisfaction and perceived control over making life changes [32]. Another study demonstrated that adults with mental illness noted improved positive self-assessments of their mental health following online peer support interventions [33]. Peer support has also shown effectiveness among young adults, improving mental health outcomes such as reducing loneliness and improving self-esteem [34].

The benefits of peer support also apply to younger populations. A study of a free, anonymous, UK-based online forum providing emotional support to youth and young adults aged 11-25 years demonstrated positive effects associated with discussing emotional and mental health concerns. The majority of online peer interactions were emotional in nature and involved sharing similar personal experiences, while others were informational, offering specific guidance or advice [31]. A systematic review examining the impact of peer support on anxiety and depression among youth and young adults noted a trend towards symptom reduction. The mean age across included studies ranged from 14 to 24 years. Although the magnitude of peer support's impact varied across studies and fewer reported statistically significant reductions in anxiety and depression, most documented reductions in negative affect in general [30].

While peer support is not a substitute for clinical mental health care, evidence indicates that it provides valuable adjunctive benefits that enhance overall support and well-being [29]. For example, a 2018 randomized controlled trial involving adolescents with mental health conditions found that reductions in stigma-related stress were associated with increased disclosure of diagnoses to others [35]. Similarly, a study conducted in Australia reported improved shared decision-making among participants aged 13-17 years who received an intervention supported by youth peer workers [36].

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Additionally, a study involving adolescents with schizophrenia indicated that digital peer support (DPS) improved self-efficacy and decreased self-reported depressive symptoms [37].

Beyond these well-documented barriers to care, including mental health stigma and unsupportive family environments [19], there is also consistent evidence suggesting that adolescents are more likely to seek help from peers before turning to typical medical systems [30]. This highlights the importance of considering whether such peer interactions produce the desired outcomes adolescents are seeking. Given that today's youth are heavily immersed in digital technologies and social media, they are a well-suited population to evaluate the impact of DPS interventions, including which modalities may be the most impactful in bridging to higher level mental health care. To assess the feasibility of digital solutions for low-income adolescents specifically, it is necessary to examine the current patterns of access to and use of digital devices.

1.3. Technology

Exposure to technology has become the new normal among adolescents. Members of Generation Z (born 1995-2012) and Generation Alpha (born 2013-2025) have grown up immersed in online environments, with approximately 95% of teens aged 13-18 years reporting access to a smartphone [38]. In the past, differences between access to and proficiency with digital technology, known as the digital divide, have been much wider across both urban and rural populations [39]. When considering Penchansky and Thomas' access framework in the age of digital care delivery, availability and accessibility are increasingly dependent on access to digital devices as well as the ability to effectively use technology [20]. Recent evidence suggests that this digital divide is narrowing among adolescents, with those from lower SES households reporting smartphone access comparable to peers from higher-income households, although they remain less likely to have a computer or tablet at home [40].

Adolescents are faced with the complexities of navigating social interactions within digital environments. A 2024 Pew Research Center survey revealed that 96% of U.S. teens aged 13-17 years report daily internet use, and 46% report being online "almost constantly," increasing twofold over the past decade [41]. There are only minor differences in the use of technology by SES. Lower-income adolescents are more likely to use social media to communicate with friends, while texting is more common among higher-income peers [41]. An earlier survey of teens aged 13-17 years explored how teens form and sustain social relationships [41] and showed that although school remains an important setting for social connection, online interactions have become increasingly common. Smartphone ownership is associated with an increased use of text messaging to communicate with close friends, and digital platforms, such as social media and online gaming, are commonly used to meet new friends and interact with existing ones. Engagement with these digital formats is associated with increased feelings of connectedness, and teens use their digital technology as the way to maintain relationships with their "offline" friends [42]. More recently, a 2023 analysis of 203 teens noted that digital interactions co-occur with in-person settings such as school, with 97% of surveyed students reporting smartphone use during the school day, most commonly for social media and gaming apps [43].

In addition to social media platforms, adolescents are increasingly engaging with AI chatbots like ChatGPT, Google Gemini, and Anthropic's Claude, among others. A study found that one in eight adolescents and young adults reported using AI chatbots for mental health support and most users returned to these platforms at least on a monthly basis [44]. Another study reported that 50% of adolescents aged 15 to 17 years used generative AI [45]. Beyond mental health support, users also use large language model (LLM)-based chatbots for problem-solving in both academic and non-academic settings, such as assisting with schoolwork, explaining concepts, and personal advice [46]. Since chatbots are available 24/7 and provide rapid responses in a perceived non-judgmental environment, they are frequented by users from all ages worldwide.

Despite their popularity, the sudden appropriation of AI chatbots into many aspects of daily life has also raised many concerns. LLM-based models rely on user prompts and are prone to validating

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and reinforcing user beliefs rather than challenging them [47]. This can cause user delusions and maladaptive thinking patterns, worsening mental health [48]. Additionally, they are not developed with clinical safety guidelines or human oversight, which makes them unsuitable settings for discussing sensitive mental health information and seeking advice [49]. Another well-established shortcoming of LLM-based AI models is their difficulty in understanding human language, including figurative language, sarcasm, and other human nuances [50,51]. As a result, in many instances, AI chatbots have not been able to recognize suicidal ideation and have contributed to users committing suicide [52–54].

Given that so much of teens' attention, social interactions, and relationships now occur in digital formats, assessing the potential benefits of DPS at the population level requires examination of empathy development in modern adolescents, including whether they demonstrate comparable capacity for empathy in digital social interactions as they do in in-person interactions.

1.4. Digital Empathy

Online interactions allow teens to connect and provide emotional support to each other; however, some still struggle to find spaces where they can express themselves safely and receive empathetic responses. Empathy tends to be stronger for one's perceived "in-group" members compared with those outside the group [55]. Social media plays an important role in supporting teens through personal challenges but can also have a negative impact. In a survey, 21% of teens reported that social media use made them "feel worse about their own life" [41]. However, more recent studies indicate that social media has positive effects among teens, increasing their capacity to recognize and share other's emotions [56,57]. Other evidence suggests that adolescents' ability to express their emotions does not vary between online and in person settings [58]. However, empathy burnout (i.e., compassion fatigue), or becoming less empathetic to someone else's struggle due to a prolonged exposure to distressing social issues, is also documented among social media and technology users [59]. Survey results indicate that 57% of respondents attributed empathy fatigue to social media use, though this effect varied by social media platform [59].

1.5. Peer Support and Self-Determination Theory

The effectiveness of peer support interventions can be understood in the framework of self-determination theory, first conceptualized by Deci and Ryan in 1985 [60]. According to this theory, three fundamental factors, namely autonomy, competence, and relatedness, facilitate individuals' progression toward emotional change. Autonomy refers to an individual's inclination to self-direct and exert control over their actions, while competence reflects the desire to acquire and master new skills before integrating them into behavior, and relatedness encompasses the need for interpersonal connections.

In peer support settings, these needs may be supported to a greater extent. As teens process emotional challenges, they may feel more autonomous by the absence of a mental health professional or adult to serve as the expert guide. Competence may be reinforced through mirroring, validating, and recognizing previously successful coping skills. Relatedness may be bolstered by participating in a peer community that normalizes emotional struggles by connecting to peers with shared experiences [61]. Together, these dynamics are hypothesized to positively impact mental health and well-being [61]. By leveraging the principles of autonomy, competence, and relatedness, peer support interventions offer a unique, potentially transformative, and more accessible approach to addressing emotional difficulties and promoting individuals' overall psychological resilience. With the rise of DPS, opportunities to extend the reach and impact of peer support interventions have expanded. Numerous studies have explored the effectiveness of DPS, often in combination with evidence-based practices, in addressing mental health needs [62–64].

1.6. Real-time Moderated Digital Peer Support

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Several established elements of DPS enhance both the process and impact of peer interventions, with moderation consistently identified as one of the most influential factors. The introduction of live, real-time moderation, provided either by trained professionals or peers themselves, has demonstrated a positive effect on user outcomes, including increased engagement and perceived effectiveness compared with non-moderated support [65]. The term "moderation" has increasingly been applied to asynchronous, post-hoc review mechanisms; however, such appropriation risks diluting its conceptual integrity. Moderation, properly understood, denotes synchronous, interactive oversight, and should not be conflated with after-the-fact content adjustment. Moderated peer interventions promote higher levels of user trust and safety [66]. At a protective level, moderation also protects against acute risks, such as hostility, direct attacks, and the spread of misinformation [67]. This is especially important in digital peer support addressing emotional distress, where users may be more susceptible to harm if the conversation is not evidence-based. Moderators have also been found to keep users engaged for longer durations, maintain civility and positivity in chats, prevent disruptive topic changes, and foster stronger user cohesion [66].

Given the digital immersion of contemporary adolescents, further research is needed to understand how moderated, safe online environments may counterbalance negative dynamics within the digital spaces and foster empathy and emotional resilience in users. To address this need in adolescents, we evaluated the effectiveness of an anonymous, chat-based DPS service that offers real-time conversational support and features sub-clinical trained human moderators who facilitate constructive discussions while ensuring a safe and respectful environment. In a previous study, we evaluated the impact of DPS among older adults and found significant reductions in short-term loneliness and increases in optimism after only a few minutes of chat engagement [68]. Building on our prior work, the current study focuses on government plan-sponsored teens in the southwest and Midwest US, who were given no-cost access to the same anonymous, real-time moderated DPS service. We examine how sentiment states changed throughout the chat conversations to better understand the dynamics of DPS among youth, focusing on non-clinical sentiment distress domains, including sadness, stress, insecurity, loneliness, anger, and anxiety, as well as optimism.

2. Materials and Methods

2.1. Supportiv Service Model

Supportiv is a 24/7 browser-based, moderated, synchronous live chat service that matches users into small, anonymous groups based on their shared concerns. Users voluntarily opt into Supportiv's anonymous peer-to-peer support platform through an informed, self-selection process. The interaction begins with the prompt, "What's your struggle?" where they share a free text description of their real-time concern.

Using AI-driven Natural Language Processing (NLP), the users are matched with others facing similar issues, forming small groups of no more than five people in a live chat which is guided in real-time by a trained sub-clinical human moderator. We implemented a transformer-based language classifier to identify whether an incoming message was authored by an adolescent. When a message is classified, the system restricts peer matching to other adolescent users to enhance age-appropriate support and promote relatable peer interactions. Users are auto-selected, not self-selected, into either a moderator-led small group or a one-on-one chat with a moderator.

Trained human moderators facilitate discussions, ensure a psychologically safe environment by enforcing chat rules, and leading collaborative problem-solving efforts. Another key role of the moderators is to identify and exclude individuals who intentionally disrupt conversations with inflammatory or irrelevant remarks, ensuring that the DPS space remains supportive and constructive.

Moderators have all completed formal sub-clinical training and demonstrated competence in skills such as asking facilitative questions, providing an empathetic experience, sharing relevant resources, and, when necessary, connecting users to crisis services. They are also regularly monitored

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for their handling of crises and additional service delivery quality. Supportiv has a proprietary AI-driven suicidality detection tool and documented referral protocols to address concerns, including medical emergencies, physical danger (suicide risk, domestic violence, sexual assault, and elder abuse), and panic attacks [65]. Prior to accessing services, individuals are required to review and consent to the Terms of Use and Privacy Policy, including consent for the use of their anonymous data, which is inherently anonymous from the outset, not anonymized post-collection, for research and service improvement purposes. No personally identifiable information (PII), personal health information (PHI), or HIPAA-protected health information is required. All data handling complies with the California Consumer Privacy Act (CCPA) and the General Data Protection Regulation (GDPR).

2.2. Study Design and Population

This observational and retrospective study analyzed government plan-sponsored teens aged 13-20 years who had a no-cost access to the service between March 1, 2024, and December 31, 2024, through their government-sponsored health plan and their school district. Only chat sessions containing at least three messages were included in the analysis. Sessions shorter than three messages were excluded due to concerns about insufficient user engagement, which would limit the ability to assess the impact of DPS. Conversations with irrelevant messages were also excluded as they did not reflect genuine emotional expression or authentic engagement with the group and could distort analyses of sentiment change and peer support dynamics. After eligibility, a total of 1,005 DPS conversations from 663 distinct users were analyzed.

This study was reviewed by the Pearl Institutional Review Board (IRB) and determined to be exempt from human subjects' review under 45 CFR 46.104(d)(4)(ii) (secondary research use of existing data). The exemption determination was issued on January 31, 2025 (IRB #2025-0043). Because the study involved retrospective analysis of de-identified data, informed consent was not required.

2.3. Conversation Setting

Once users typed a brief description of their struggle, they were automatically matched within one minute (mean time: 29.78 seconds, median time: 13.39 seconds) either to an existing live small-group chat or to a one-on-one chat with a moderator, where they could later be joined by other concurrent users auto-matched for experiencing similar struggles.

Newly joined participants received a short narrative summary of the ongoing discussion to ensure continuity and context. Moderators played a central role in facilitating these conversations by posing open-ended questions, guiding discussions, and fostering participant engagement.

Additionally, moderators shared relevant resources tailored to the issues discussed, including practical advice articles and informational materials aimed at enhancing users' understanding of their struggles. At the conclusion of the conversation, users were given the opportunity to provide feedback (representative feedback examples are included in the results section).

2.4. Sentiment Analysis

We evaluated different state-level sentiments using OpenAI's LLM model, GPT-4o-mini, employing a few-shot learning approach [68]. Few-shot learning refers to a method in which a model is provided with a small number of labeled examples (or "shots") within the prompt to guide its responses. Instead of requiring extensive fine-tuning on large labeled datasets, the model learns from these examples in real time, allowing it to generalize and perform the desired task effectively. To enhance performance, the model was given examples of manually selected and rated messages as references. In our prior work, we demonstrated that this approach is comparable to or superior to state-of-the-art models [67].

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State-level sentiments refer to emotions that occur within a specific time window that reflect the users' current affective tone, physiological activation, and cognitive patterns which can fluctuate, rather than their long-term psychological or personality traits. This study examined sentiment states that were expressed within DPS conversations. The following sentiments were evaluated: sadness, stress, insecurity, loneliness, anger, anxiety, and optimism. For each sentiment, the model was provided with the user's message along with the context of the preceding conversation, which included all messages since the previous message from the user in question. The model then assigned a score to each sentiment on a scale from 1 to 10, where 1 represents the minimum and 10 the maximum level of expressed sentiment. The 1-10 scale provides sufficient granularity to capture shifts in sentiment expression, allowing differentiation of subtle variations in intensity while maintaining interpretability. To ensure the scale effectively represented real-world sentiment dynamics, examples were selected from real data spanning the full range of expression, from subtle to intense. This approach enhances the robustness of the model's scoring and its applicability to diverse sentiment contexts. Examples for the scores 1, 5, and 10 are portrayed in Appendix A.

Importantly, some messages did not allow inference of the sentiment state because they were unrelated to users sharing their concerns, such as users asking moderators, "Are you a human?" or making unrelated statements to the conversation (for example, "My dad is calling me"). In cases where there was insufficient information to evaluate sentiment, the model using the same few-shot learning approach was instructed not to assign a score in order to avoid introducing noise or misclassification due to uncertainty.

To assess changes in sentiment state over the course of the peer support chat, we analyzed scores as the conversation progressed. Linear interpolation was used to map each conversation from 0 to 100% progression, ensuring that all conversations were scaled to a common reference frame regardless of length.

Analysis included conversations with initial negative affect to examine the effect of digital peer support. To identify these conversations, we took the maximum value of the sentiment scores from the first three messages and selected conversations with a score of 5 or higher, which indicates that a particular sentiment is present. This approach accounted for the possibility that initial messages may contain polite greetings or neutral introductions before transitioning to the core issue, which more accurately reflects the state of concern. By using the maximum value within this window, we aimed to capture the strongest negative sentiment expressed early in the conversation while mitigating the influence of neutral or non-representative opening statements. This ensured that we were tracking meaningful shifts over the course of a conversation, rather than including cases in which the sentiment of interest was minimal or absent. By focusing on conversations in which a given sentiment was salient, we aimed to better capture relevant changes.

Since this thresholding method was applied separately for each sentiment, different subsets of conversations were analyzed. We observed that the first 10% and last 10% of the conversations often included introductory and concluding messages that consisted of greetings, introductions, expressions of gratitude, or other formalities that do not necessarily reflect the core concern of the interactions. To mitigate this bias, we excluded the first and last 10% of each conversation and focused on the remaining central portion.

Within this core segment, we fitted a linear model to the sentiment scores and used the slope of the fitted line as an indicator of change. A negative slope indicates a reduction in distress over the course of the conversation, whereas a flatter or positive slope suggests stability or worsening of the initial sentiment state. This method allowed us to quantify the overall effect of digital peer support on sentiment trajectories while minimizing the influence of structural artifacts in conversation flow.

We used a non-parametric Wilcoxon signed-rank test, assuming a non-normal distribution, to evaluate whether the effects were significantly different and computed effect size using rank-biserial correlation. Additionally, we conducted a separate comparison of sentiment states at the beginning and end of the conversation by calculating the mean sentiment score of the first three and last three messages. Our data suggest that adolescents often do not clearly articulate their concerns in their

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initial description of "struggle" and may provide non-informative inputs such as "I need to talk", or simple greetings (e.g., "Hello"), which do not allow for an accurate assessment of their initial sentiment state. However, considering the first three messages generally provides sufficient context to capture sentiment context. Based on this observation, we conducted a comparative analysis between the sentiment scores of the first and last three messages in each conversation.

To assess the significance of these changes, we again employed the Wilcoxon signed-rank test and calculated rank-biserial correlation as a measure of effect size.

2.5. Topic Modeling

We employed a topic modeling framework using LLM-based categorization to assign topics and subtopics to text data efficiently. A predefined list of topics was manually selected after reviewing conversation content. Texts were processed using GPT-4o-mini using a structured prompt to categorize them into selected topics and subtopics. Classification accuracy was manually verified. This approach was selected because it balanced user control, efficiency, and consistency.

2.6. Session Timing and Device Type

We recorded users' joining times and converted them to local time to account for time zone differences. Additionally, we collected data on the type of device used to access the service, allowing for a more comprehensive analysis of digital engagement and interaction patterns.

2.7. Statistical and Visualization Software

Statistical analyses and data visualization were conducted in Python using pandas 2.2.0, numpy 1.26.4, SciPy 1.13.1, and matplotlib 3.9.3.

3. Results

Due to irrelevant messages, 1.3% of conversations were excluded. A total of 1,005 conversations from 663 users that met the inclusion criteria were included in the final analysis from March 2024 to December 2024.

3.1. User Demographics

Approximately 19.6% of users (n=130) reported their age, with a median age of 16 years (mean = 15.98). Out of the users that disclosed their gender (27.9%, n=185), most users were female (68.6%, n=127), 25.4% were male (n=47) and 5.9% were non-binary (n=11). Users came from different ethnic backgrounds (27.0%, n=179), with 40.8% of users identifying as White (n=73), 23.5% as Hispanic or Latino (n=42), 18.4% as Black or African American (n=33), 7.8% as Asian (n=14), 6.1% as American Indian or Alaska Native (n=11), 1.7% as Middle Eastern or North African (n=3) and 1.7% as Native Hawaiian or other Pacific Islander (n=3).

3.2. DPS Session Characteristics

Among these conversations, session duration varied, with a mean duration of 29.15 minutes (SD = 30.71) and a median duration of 18.19 minutes, indicating a positively skewed distribution (Figure 1). The majority of interactions (n=781 conversations, 77.7%) occurred in one-on-one sessions with a peer support moderator, while the remainder took place in moderated small group discussions with peers and moderators.

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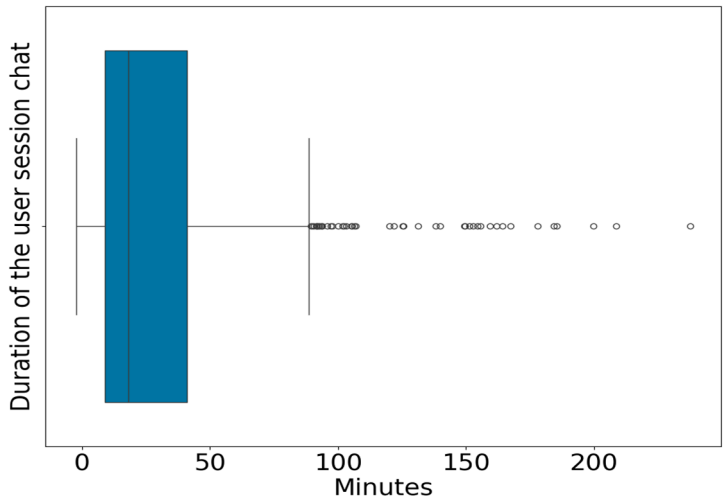

Figure 1. Average duration of the user session chat (n=1005 participants) lasted on average 29.15 minutes (SD = 30.71) and a median duration of 18.19 minutes.

Most conversations contained fewer than 1,000 words in total (median number of words = 698, median number of messages = 12) (Figure 2). The majority of conversations were conducted on mobile devices, accounting for 80.89% of interactions. Desktop computers were used in 18.47% of cases, while tablets were the least common device type, representing only 0.65% of interactions.

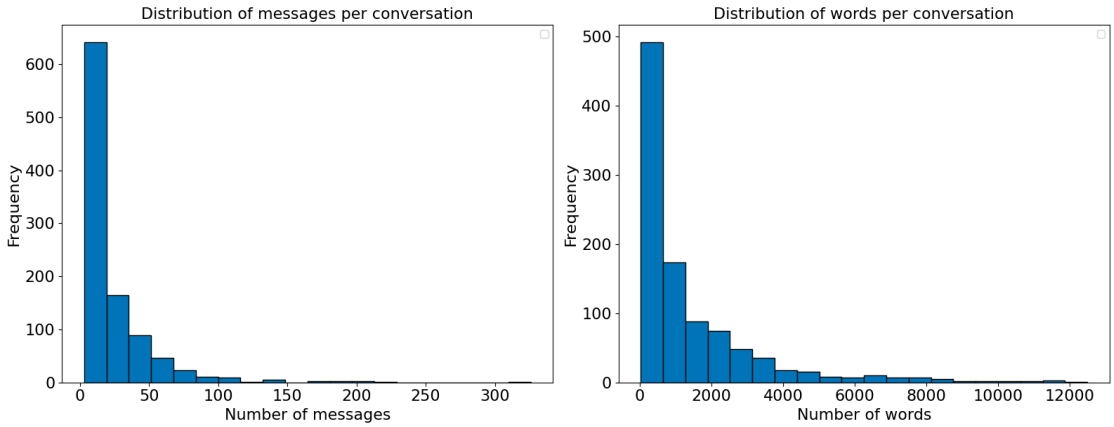

Figure 2. Distribution of messages and words across all users in live chat conversations.

Temporal analysis of service usage revealed distinct patterns in adolescents' engagement with DPS. As illustrated in Figure 3, usage peaked between 1:00 and 3:00 PM, and a sustained surge in conversations occurred in the evening between 7:00 PM until midnight.

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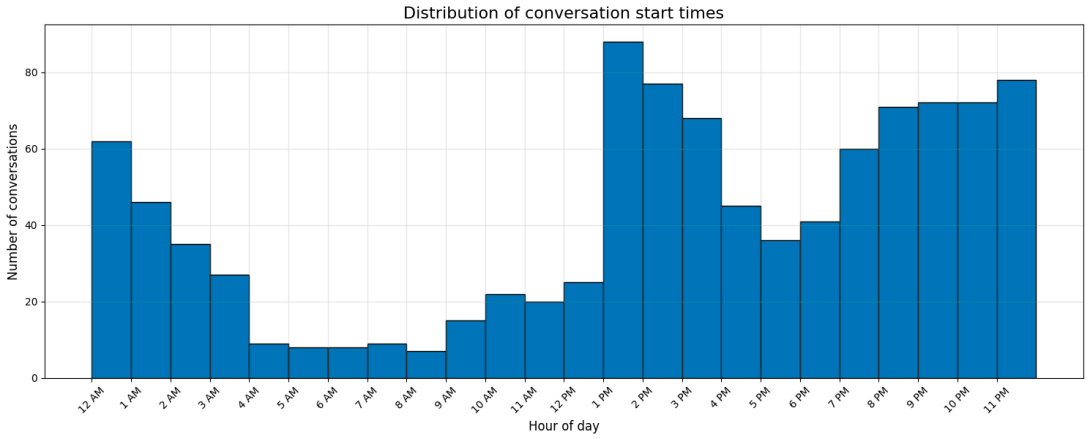

Figure 3. Distribution of live chat conversations by their start times. This histogram shows the timing of conversation initiations throughout the day with two notable peaks: an early afternoon surge around 1:00–2:00 PM and a major evening increase starting at 7:00 PM and peaking between 9:00 PM and midnight.

3.3. Discussion Topic

The most frequently discussed topic was social connection (39.84%), followed by mental health conditions (27.26%), loneliness (9.86%), stress (9.15%), and identity (3.92%). Other topics, including productivity or work, financial concerns, physical health, and burnout, were discussed less frequently, each comprising less than 3% of the conversations. Within the broader category of social connection, the most prominent subtopics were relationships (80.56%), followed by family (11.36%), breakups (3.03%), and communication (2.78%). Representative struggle descriptions for the top five topics are provided in Appendix B.

3.4. Sentiment Outcomes

Regarding the progression of sentiment states throughout the conversations, we observed a consistent improvement across all analyzed dimensions, as shown in Figure 4. Specifically, all negative sentiments demonstrated significant decreases (all $P < 0.001$), with the greatest reductions observed for anger (46.94%; effect size: 0.87), loneliness (31.99%; effect size: 0.79), and stress (31.02%; effect size: 0.82). There were also reductions in anxiety 29.81% (effect size: 0.79), sadness (28.64%; effect size: 0.81), and insecurity (24.17%; effect size: 0.75) over the course of the conversations. There was a corresponding significant increase in overall optimism, with a 47.69% improvement ($P < 0.001$; effect size: 0.70).

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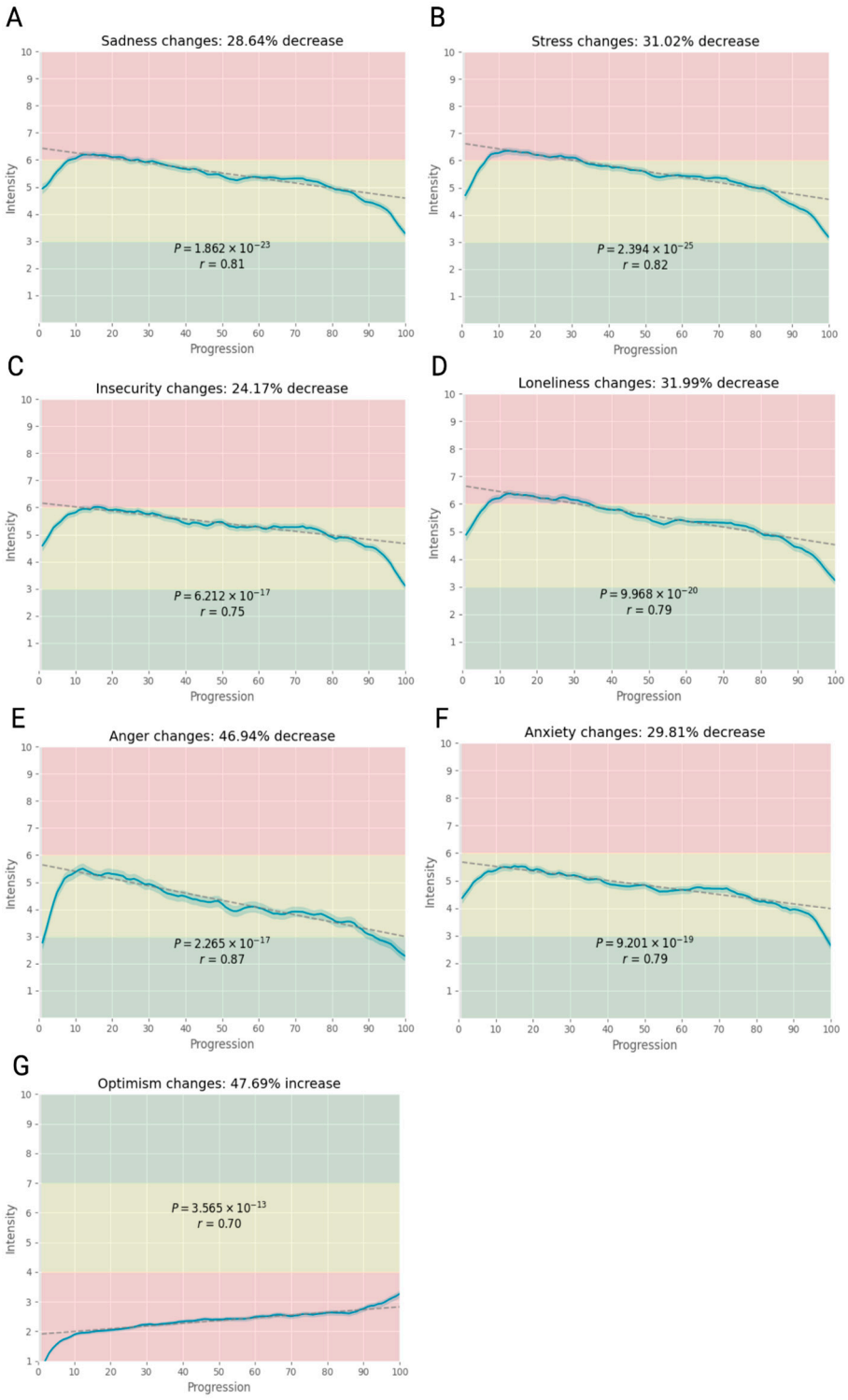

Figure 4. Sentiment trends throughout conversation progression. Sentiment scores were observed as conversations progressed. Shaded areas represent the standard error of mean. A-F. The green region (scores 1–4) represents low levels of sentiment, yellow (4–7) represents moderate levels, and red (7–10) indicates high momentary sentiment. G. For overall optimism, the red region represents negative values (scores 6–10), yellow area represents neutral values (3–6), and green area represents positive range (0–3).

Comparing sentiment states at the beginning and end of conversations, we observed significant improvement across all sentiments (all $P < 0.001$), as shown in Figure 5. Because thresholding criteria were applied to include only conversations with elevated negative sentiment scores, the number of

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conversations analyzed varied. The most pronounced reductions in negative sentiment were observed for loneliness, with mean scores declining from 6.97 to 4.61 (Δ-2.36) (r = 0.84) across 263 conversations, anger, with mean scores declining from 5.82 to 3.48 (Δ-2.34) over 78 conversations (r = 0.88) and stress, with mean scores declining from 6.72 to 4.50 (Δ-2.22) over 278 conversations (r = 0.81). Similarly, sadness levels decreased from 6.66 to 4.51 (Δ-2.15) across 297 conversations (r = 0.81), indicating a meaningful reduction. Anxiety also significantly decreased, with 171 conversations showing a reduction from 6.31 to 4.30 (Δ-2.01) (r = 0.78). Insecurity showed a notable decline, with mean scores decreasing from 6.86 in the first three messages to 4.95 (Δ-1.91) in the last three messages across 184 conversations (r = 0.69). In contrast, a significant improvement in optimism was observed over the course of conversations with an increase from 1.96 to 2.94 (Δ+0.98) over 648 analyzed conversations (r = 0.71). Together, these targeted comparisons between the beginning and end of conversations further support the patterns of state-level sentiment improvement observed across all sentiment types. The largest improvements in loneliness, anger, stress and sadness suggest that digital peer support may increase peer empathy, validation and perceived connectedness, which are all mechanisms that may in turn reduce user distress.

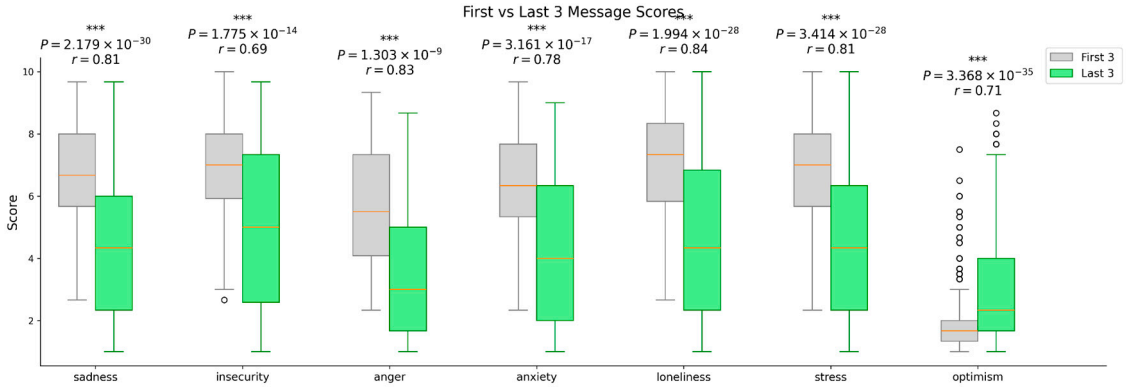

Figure 5. Comparison of initial and final sentiment states across conversations. For each sentiment, the first three scores (gray) and last three scores (green) were averaged per conversation and compared. Filled box plots display the distribution of scores, with the central orange line indicating the median, box edges denoting the interquartile range (IQR), and whiskers extending to 1.5 times the IQR. *P*<.001 is denoted with ***.

Lastly, we analyzed user feedback and identified several common themes in user experiences. One prominent theme was feeling heard and understood, with many users' expressing appreciation for being listened to without judgment (Appendix C). Another key theme was changes in sentiment state, as users often reported that the chats helped them process their emotions and feel lighter, highlighting the comfort provided by DPS conversations. We also observed that some users enjoyed helping others, finding meaning in both supporting peers and reflecting on their own experiences. Additionally, users commended moderators' kindness, patience, and understanding. These themes demonstrate the positive impact of the interactions, providing state-level sentiment relief and a strong sense of community.

4. Discussion

4.1. Principal Findings

Among this cohort of government-plan-sponsored teens, use of an anonymous, synchronous, real-time moderated DPS service was associated with significant improvements across all seven studied sentiments (sadness, stress, insecurity, loneliness, anger, anxiety, and optimism). The largest reduction was observed for anger, with 46.94% decrease, followed by reductions of 31.99% and 31.02% for loneliness and stress, respectively. Similarly, anxiety, sadness, and insecurity decreased by 29.81%, 28.64%, and 24.17%, respectively. Consistent with these reductions in negative affect, there

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was a corresponding improvement in optimism by the end of the conversations (+47.69%). These reductions in distressing sentiments continued as the conversations progressed and were replicated when comparing sentiment states at the beginning and end of conversations. Together, these findings show a consistent pattern of reduced negative sentiment expression with peer interaction, reinforcing the potential value of conversation-based engagement for changes in state-level sentiment.

These findings are promising and indicate that real-time moderated DPS may be associated with improvements in multiple domains related to adolescent state-level sentiment expression. Mechanisms that influence these common sentiments are especially valuable, as they may be early indicators of more serious mental health conditions, allowing for earlier intervention, recognition of rising risk, and prevention of serious life-threatening consequences such as suicidal ideation. For instance, anger has been shown to reduce general well-being in adolescents aged 12-14 years [69]. Chronic loneliness can negatively impact adolescents' emotional regulation during social interactions and also decrease willingness to engage socially [70]. Adolescents experiencing chronic stress may also be at risk for adverse neurological changes involving the amygdala, hippocampus, and prefrontal cortex, along with physiological disruptions [71]. Similarly, sadness in adolescents has been linked to impairments across multiple life domains, such as family relationships, peer connections, and educational outcomes [72].

Although empathy was not directly measured, the observed improvements in optimism sentiment scores and reductions in negative sentiment scores following digital peer interactions suggest a potential relationship with existing literature indicating that social media usage may be associated with increased empathy [56]. It is possible that direct digital peer support also cultivates an empathy-enhancing environment in which positive social interactions help decrease the emotional and psychological pressures teens face. This may be particularly valuable, as higher empathy has been consistently linked to increased prosocial behavior and wellbeing [73]. In parallel, usage of digital applications is continuously growing and has become the dominant mode of socializing for many adolescents [40,41]. Over recent decades, social media and messaging applications have become central components of adolescents' social lives. Thus, these digital forms of communication represent an integral part of contemporary teenage social systems rather than simply alternative channels of interaction.

Additional insights can be drawn from the topics discussed during conversations among peers. The five primary topics accounting for the majority of conversations were social connection, mental health conditions, loneliness, stress, and identity, reflecting a strong emphasis on emotional and psychological well-being. Interpersonal relationships emerged as a central concern for adolescents seeking support, with discussions primarily revolving around romantic and social connections, followed by family dynamics and challenges related to communication. This highlights the significance of multiple relationships within adolescents' social systems and their role in development and mental health, aligning with prior literature demonstrating how important interpersonal relationships are for protecting and affecting adolescent emotional well-being [74]. The consistency of these topics across conversations may also suggest that adolescents face difficulty in expressing interpersonal concerns in offline settings and may therefore find comfort in online spaces where anonymity and reduced risk of conflict facilitate open and comfortable expression.

Our findings mirror national data on device ownership and use among low-income adolescents [40]. The majority of conversations were conducted via mobile devices, while tablets were the least commonly used. The predominance of mobile devices suggests that adolescents primarily engage in conversations in flexible, on-the-go contexts, which may influence how they express emotions and articulate concerns. Usage peaked in the early afternoon and evening, suggesting that some users may reach out during school breaks or lunch periods, with the highest levels of engagement occurring in the late evening and late-night hours. This sustained increase in late hours aligns with periods when adolescents may experience heightened emotional distress or have greater privacy to seek support. These findings highlight the importance of ensuring service availability during peak usage times, particularly in the evening, when demand is highest.

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4.2. Potential Applications

4.2.1. Cyberbullying

Given its accessibility, ease of use, and anonymity, real-time moderated DPS, like Supportiv, may offer a potential solution for additional adolescent mental health concerns. For instance, the rise of cyberbullying has become an increasing concern, with prevalence estimates ranging from 20-40% of adolescents, with youth aged 12-14 years at highest risk [75]. The rise of cyberbullying is thought to be partly due to digital social media environments that allow participants to evade the supervision generally present in face-to-face, school-based interactions. Adolescents that experience cyberbullying may face many negative consequences, including adverse psychological effects and increased risk of mental health conditions. Depression, social anxiety, low self-esteem and help-seeking behavior, loneliness, sleep disturbances, and suicidal ideation have all been reported at higher rates among victims of severe cyberbullying [75].

Expanded access to real-time moderated DPS could provide adolescents with a safe, anonymous setting to process these experiences without fear of further victimization. This intervention may especially benefit school and community-based organizations seeking to address the downstream consequences of cyberbullying.

4.2.2. Self-Esteem

Given the established relationship between low self-esteem and emotional distress, the statistically significant decreases in negative sentiment scores suggest that DPS may also have applicability in addressing decreases in self-esteem commonly reported among cyberbullying victims [75,76]. The potential benefits extend beyond this population, as improvements in self-esteem have also been associated with positive outcomes across multiple domains, such as relationships, education, occupations, physical fitness, and reduced antisocial behavior [77]. Additionally, evidence suggests that higher self-esteem is associated with decreased excessive social media use among adolescents [78], potentially due to improved self-regulation and control of addictive tendencies. This may be an area for future research among adolescents, as it may indicate that DPS contributes to healthier social media behaviors and broader mental health benefits.

4.2.3. Safety of Digital Environments

Social media platforms facing increasing criticism and pressure to protect adolescent well-being could consider integrating objective, third party services such as anonymous, real-time moderated DPS, especially since evidence indicates increased social media use is linked to decreased self-esteem [79]. While social media platforms can provide a space for healthy social engagement, they lack continuous, human moderation capable of preventing harmful interactions in real time. Although certain algorithmic content moderation systems can identify and censor certain words and phrases, many harmful comments rely on user reporting and are reviewed at a later time. In contrast, moderated digital peer support provides active oversight and immediate intervention. Furthermore, anonymity can increase willingness to engage with sensitive information, supporting the value of such services in digital environments.

4.3. Study Limitations

Since Supportiv is designed to provide digitized peer support as opposed to offering clinical diagnosis or treatment, the service intentionally has anonymous users to mitigate any drawbacks or hesitancies related to sharing personal or sensitive information. From a research perspective, this anonymity prevents tracking individual users over time, limiting the ability to assess emotional and psychological states prior to and after utilizing the service, as well as trends across repeated peer interactions among returning users. Moreover, the lack of demographic information restricts our ability to examine potential variations in DPS effectiveness by factors such as race, gender or gender

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identity. It is also unknown whether government-plan-sponsored who used Supportiv differ from those enrolled in the same plans but did not engage in DPS services.

This study was also limited by its retrospective observational design. Because there was no control group, the sentiment changes that were observed cannot be interpreted as causal effects of DPS, and the improvements in sentiment may have been influenced by other factors. Additionally, sentiment expression in chat conversations is not equivalent to validated clinical symptom measures. Therefore, these findings should be interpreted as changes in state-level sentiment expression within DPS conversations, rather than changes in clinical symptom severity.

The identification of adolescent users relied on a combination of an AI-driven NLP transformer-based language classifier that determined if a user was an adolescent, and self-reported demographic data. When available, self-reported age was used to assign users to the adolescent group, however, when self-reported age was unavailable, classification relied only on the AI model. Since any automated classifier is not foolproof, there was a risk of misclassification. This allowed more users to be analyzed, but age detection methods may be improved in future anonymous digital environments.

The majority of conversations studied involved one-on-one interactions between teens and digital peer support moderators. Although these interactions do not involve a larger peer group, moderators, while trained in facilitating digital peer support conversations, are not mental health professionals and are therefore considered peers in the context of digital peer support interventions. Further research is needed to determine whether emotional distress responds similarly in larger group conversations involving multiple peers.

Additionally, the external validity of these results cannot be fully known as the study sample consisted of government-plan-sponsored adolescents from Southwestern and Midwestern United States. Therefore, we cannot directly assess whether similar changes in sentiment would be observed among all adolescents not enrolled in government sponsored plans or those from other locations. However, given widespread use of digital technologies among adolescents and the high incidence of mental health concerns across all socioeconomic strata and geographies, we hypothesize that similar results may occur in broader populations. This represents an important area for future studies.

5. Conclusions

In conclusion, real-time moderated, anonymous DPS appears promising for reducing several negative sentiment states' expressions among adolescents, such as anxiety, anger, insecurity, loneliness, sadness, and stress. DPS offers an accessible and safe digital environment for teens to engage in supportive, personal discussions and meaningfully alleviate emotional distress. Our findings support the potential for DPS to be explored as a population-level intervention to expand the availability and accessibility of emotional support services.

Given the higher incidence of mental health conditions and access barriers faced by adolescents from low-income households, this type of sponsored, no-cost-to-end-user DPS service may be particularly valuable in addressing emotional distress that contributes to the larger youth mental health crisis among this especially vulnerable population.

Author Contributions: Conceptualization, A.S., K.K., H.N. and Z.D; methodology, A.S. and Z.D. software, Z.D.; validation, H.N.; formal analysis, A.S.; resources, A.S. and H.N.; data curation, A.S. and K.K.; writing—original draft preparation, A.S. and K.K.; writing—review and editing, A.S., H.N. and Z.D.; visualization, A.S.; supervision, H.N. and Z.D.; project administration, H.N. and Z.D. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was determined to be exempt by the Pearl Institutional Review Board under 45 CFR 46.104(d)(4)(ii) (IRB 2025-0043). A consent-to-participate statement was not required due to the retrospective nature of the data analysis.

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Informed Consent Statement: Informed consent for this retrospective analysis was waived by Pearl IRB due to the use of de-identified retrospective data. Prior to accessing the service, users agreed to the platform Terms of Use and Privacy Policy, including use of anonymous data for research and service improvement.

Data Availability Statement: The datasets generated and analyzed during the current study are not publicly available due to proprietary data. Data is available from the corresponding author on reasonable request.

Acknowledgments: This work was sponsored by Supportiv. The authors would like to thank Dr. Alejandro Martinez of Stanford University for providing the original peer support training for the Supportiv moderators, and Dylan Dudeck, M.S. and Ilayda Ozsan McMillan, Ph.D. for their contributions to the completion of this manuscript.

Conflicts of Interest: All authors were employees of Supportiv at the time of this study.

Abbreviations

The following abbreviations are used in this manuscript:

CCPA	California Consumer Privacy Act
DPS	Digital Peer Support
GDPR	General Data Protection Regulation
HIPAA	Health Insurance Portability and Accountability Act of 1996
IRB	Institutional Review Board
LLM	Large Language Model
NLP	Natural Language Processing
PHI	Personal Health Information
PII	Personally Identifiable Information

Appendix A

Examples provided to interpret emotion intensities in a few-shot manner.

A. Insecurity

Score 1 (low levels of insecurity):

“I love the person I became I am happier and more importantly mindful of what I do”

Score 5 (medium levels of insecurity):

” Yes, I don't think too highly of myself. I think that I'm a little on the chubby side. I need to work out a little bit. Which I have been getting into.”

Score 10 (highest levels of insecurity):

“Sometimes i feel like a husk. other times i feel gross and not worthy of perception. i hate my body."

Stress

Score 1 (low levels of stress):

“Life is actually going pretty good lately, just wanting to talk to someone so someone can care about how good my life is going.”

Score 5 (medium levels of stress):

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" My boyfriend and I have been together for like 5 years, but there's been so many new things and changes and situations that keeps coming up"

Score 10 (highest levels of stress):

"The whole experience of this stress anxiety and depression have been riding on my back for so long and it's been awful like being forced to wear literal tons of weights on your back"

Sadness

Score 1 (low levels of sadness):

"i'm feeling okay today, just want to chat a bit"

Score 5 (medium levels of sadness):

" It's just sad to me that he won't even give me a chance"

Score 10 (highest levels of sadness):

"I feel alone and depressed and very dark and invisible. My life has been terrible for years and I never knew what it was like to receive care."

Anger

Score 1 (low levels of anger):

"Well, you're really calmed me down, I feel much better now"

Score 5 (medium levels of anger):

" Yeah it annoyed me because I would never do this to them... and when I express those emotions, I get called the mean and fake friend"

Score 10 (highest levels of anger):

"I feel anger a lot of anger like at myself my family all the people that could have helped me but chose not to"

Anxiety

Score 1 (low levels of anxiety):

"The other alternatives I have explored is drawing, music, and talking to my mom that I only trust to talk to and even I hug her too!"

Score 5 (medium levels of anxiety):

"it's kind of a lot and i might be overreacting it but it's just the stress of keeping up grades and getting frustrated with myself"

Score 10 (highest levels of anxiety):

"So intense that i can hear my heart racing and my fingers sweating and i get the chills in my spine"

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Loneliness

Score 1 (low levels of loneliness):

“My best friend is the person I usually go to when I'm ranting and she rants back. We go to each other all the time for advice or for a pick me up”

Score 5 (medium levels of loneliness):

” I was alone a lot at in-person things like school or clubs, but I had online friends. I can deal with my own issues alone most of the time but sometimes I do crave interaction or social support.”

Score 10 (highest levels of loneliness):

“My mom abandoned me when I was around five, I lived what my grandmother she never let us leave the house other than going to school so I didn't have much of a social life and I didn't really know how to talk to other kids my age, so I got bullied a lot"

Optimism

Score 1 (low levels of optimism):

“Some people are just doomed no matter what they do”

Score 5 (medium levels of optimism):

”Honestly, some days I wonder why I bother, but that’s when I am frustrated. I try to imagine the restart”

Score 10 (highest levels of optimism):

“It does fill me back up it shows me that there us good in ppl the warmth and the smile does it for me that shows me humanity is worth every last bit of effort"

Appendix B

Examples of user’s struggles for the most common topics.

A. Social connection

“The guy I’m talking to is giving me mixed signals and I don’t know what to do”

Mental health conditions

“I have problems with anxiety, I may have ADHD and I don't know if I am depressed, but I also may have problems with my feelings and emotions.”

Loneliness

“I'm really lonely because I have no friends and I can't actually do anything about it to fix how I feel”

Stress

“Life makes me feel stressful with inadequate solutions to find peace”

Identity

“I’m sad because I can’t do hockey as a girl it really makes me depressed”

Appendix C

 doi:10.20944/preprints202605.1490.v1

Examples of user reviews highlighting common themes.

A. Feeling heard and understood

"I feel less anxious now that I've talked about my thoughts and feelings. I felt heard and they gave me good advice. I was able to say anything without any judgment or hesitation."

Emotional relief

"I do feel a bit better, like some weight was lifted off my chest & shoulders :)"

Enjoyment of helping others

"I love helping people with their thoughts, it was lovely! <3"

Praise and gratitude towards moderators

"[moderator] was a very good moderator, understood my feeling and provided helpful resources, is very kind and understanding about what you have to say, no matter the topic."

References

1. Acri MC, Bornheimer LA, Jessell L, et al. The intersection of extreme poverty and familial mental health in the United States. *Social Work in Mental Health*. 2017;15(6):677-689. doi:10.1080/15332985.2017.1319893
2. Hudson CG. Socioeconomic Status and Mental Illness: Tests of the Social Causation and Selection Hypotheses. *American Journal of Orthopsychiatry*. 2005;75(1):3-18. doi:10.1037/0002-9432.75.1.3
3. García-Rodríguez MT, Juanatey-Rodríguez I, Seijo-Bestilleiro R, González-Martin C. Psycho-emotional distress in children and adolescents in relation to COVID-19 confinement and pandemic: A systematized review: Author lists. *Ital J Pediatr*. 2023;49(1):47. doi:10.1186/s13052-023-01450-7
4. Merikangas KR, He J ping, Burstein M, et al. Lifetime Prevalence of Mental Disorders in U.S. Adolescents: Results from the National Comorbidity Survey Replication–Adolescent Supplement (NCS-A). *Journal of the American Academy of Child & Adolescent Psychiatry*. 2010;49(10):980-989. doi:10.1016/j.jaac.2010.05.017
5. Twenge JM, Haidt J, Blake AB, McAllister C, Lemon H, Le Roy A. Worldwide increases in adolescent loneliness. *Journal of Adolescence*. 2021;93(1):257-269. doi:10.1016/j.adolescence.2021.06.006
6. Twenge JM, Martin GN, Campbell WK. Decreases in psychological well-being among American adolescents after 2012 and links to screen time during the rise of smartphone technology. *Emotion*. 2018;18(6):765-780. doi:10.1037/emo0000403
7. Salceanu C. Emotional Distress, Anxiety, and Socioeconomic Status in Adolesence. *Revista Universitară de Sociologie*. Published online March 13, 2019. Accessed February 24, 2025. https://www.ceeol.com/search/article-detail?id=818284
8. Reiss F, Meyrose AK, Otto C, Lampert T, Klasen F, Ravens-Sieberer U. Socioeconomic status, stressful life situations and mental health problems in children and adolescents: Results of the German BELLA cohort-study. Hashimoto K, ed. *PLoS ONE*. 2019;14(3):e0213700. doi:10.1371/journal.pone.0213700
9. Warrne D. *Low Income and Poverty Dynamics Implications for Child Outocmes*. Australian Institute of Family Studies. Accessed March 3, 2025. https://aifs.gov.au/sites/default/files/2022-06/sprp47_low_income_web.pdf
10. Noonan K, Burns R, Violato M. Family income, maternal psychological distress and child socio-emotional behaviour: Longitudinal findings from the UK Millennium Cohort Study. *SSM - Population Health*. 2018;4:280-290. doi:10.1016/j.ssmph.2018.03.002
11. Hodgkinson S, Godoy L, Beers LS, Lewin A. Improving Mental Health Access for Low-Income Children and Families in the Primary Care Setting. *Pediatrics*. 2017;139(1):e20151175. doi:10.1542/peds.2015-1175
12. Stagman S, Cooper J. Children's Mental Health What Every Policymaker Should Know. *NCCP*. Accessed February 26, 2025. https://www.nccp.org/wp-content/uploads/2010/04/text_929.pdf
13. Bitsko RH, Claussen AH, Lichstein J, et al. Mental Health Surveillance Among Children — United States, 2013–2019. *MMWR Suppl*. 2022;71(2):1-42. doi:10.15585/mmwr.su7102a1
14. Polanczyk GV, Salum GA, Sugaya LS, Caye A, Rohde LA. Annual Research Review: A meta-analysis of the worldwide prevalence of mental disorders in children and adolescents. *Child Psychology Psychiatry*. 2015;56(3):345-365. doi:10.1111/jcpp.12381

 doi:10.20944/preprints202605.1490.v1

15. World Health Organization: WHO. Mental health of adolescents. *World Health Organization: WHO*. Accessed February 5, 2025. https://www.who.int/news-room/fact-sheets/detail/adolescent-mental-health. October 10, 2024
16. Suicide. National Institute of Mental Health (NIMH). https://www.nimh.nih.gov/health/statistics/suicide
17. Beckes L, Coan JA. Social Baseline Theory: The Role of Social Proximity in Emotion and Economy of Action. *Social & Personality Psych*. 2011;5(12):976-988. doi:10.1111/j.1751-9004.2011.00400.x
18. Whitney DG, Peterson MD. US National and State-Level Prevalence of Mental Health Disorders and Disparities of Mental Health Care Use in Children. *JAMA Pediatr*. 2019;173(4):389. doi:10.1001/jamapediatrics.2018.5399
19. Aguirre Velasco A, Cruz ISS, Billings J, Jimenez M, Rowe S. What are the barriers, facilitators and interventions targeting help-seeking behaviours for common mental health problems in adolescents? A systematic review. *BMC Psychiatry*. 2020;20(1):293. doi:10.1186/s12888-020-02659-0
20. Penchansky R, Thomas JW. The Concept of Access: Definition and Relationship to Consumer Satisfaction. *Medical Care*. 1981;19(2):127-140. doi:10.1097/00005650-198102000-00001
21. Sieck CJ, Rastetter M, Hefner JL, et al. The Five A's of Access for TechQuity. *Journal of Health Care for the Poor and Underserved*. 2021;32(2S):290-299. doi:10.1353/hpu.2021.0064
22. Twenge JM, Spitzberg BH, Campbell WK. Less in-person social interaction with peers among U.S. adolescents in the 21st century and links to loneliness. *Journal of Social and Personal Relationships*. 2019;36(6):1892-1913. doi:10.1177/0265407519836170
23. Mulholland H. Primary Care in Rochester and Kasson. May 9, 2024. https://communityhealth.mayoclinic.org/featured-stories/teen-emotions
24. General Emotional Changes Adolescents Experience. https://opa.hhs.gov/adolescent-health/adolescent-development-explained/emotional-development
25. Marquez J, Francis-Hew L, Humphrey N. Protective factors for resilience in adolescence: analysis of a longitudinal dataset using the residuals approach. *Child Adolesc Psychiatry Ment Health*. 2023;17(1):140. doi:10.1186/s13034-023-00687-8
26. Mental health of adolescents. Accessed February 24, 2025. https://www.who.int/news-room/fact-sheets/detail/adolescent-mental-health
27. How does bullying affect health and well-being? https://www.nichd.nih.gov/health/topics/bullying/conditioninfo/health
28. Tracy K, Wallace S. Benefits of peer support groups in the treatment of addiction. *SAR*. 2016;Volume 7:143-154. doi:10.2147/SAR.S81535
29. Cooper RE, Saunders KRK, Greenburgh A, et al. The effectiveness, implementation, and experiences of peer support approaches for mental health: a systematic umbrella review. *BMC Med*. 2024;22(1):72. doi:10.1186/s12916-024-03260-y
30. Simmons MB, Cartner S, MacDonald R, Whitson S, Bailey A, Brown E. The effectiveness of peer support from a person with lived experience of mental health challenges for young people with anxiety and depression: a systematic review. *BMC Psychiatry*. 2023;23(1):194. doi:10.1186/s12888-023-04578-2
31. Prescott J, Hanley T, Ujhelyi K. Peer Communication in Online Mental Health Forums for Young People: Directional and Nondirectional Support. *JMIR Ment Health*. 2017;4(3):e29. doi:10.2196/mental.6921
32. Davidson L, Bellamy C, Guy K, Miller R. Peer support among persons with severe mental illnesses: a review of evidence and experience. *World Psychiatry*. 2012;11(2):123-128. doi:10.1016/j.wpsyc.2012.05.009
33. Merchant R, Goldin A, Manjanatha D, et al. Opportunities to expand access to mental health services: A case for the role of online peer support communities. *Psychiatr Q*. 2022;93(2):613-625. doi:10.1007/s11126-022-09974-7
34. Richard J, Rebinsky R, Suresh R, et al. Scoping review to evaluate the effects of peer support on the mental health of young adults. *BMJ Open*. 2022;12(8):e061336. doi:10.1136/bmjopen-2022-061336
35. Mulfinger N, Müller S, Böge I, et al. Honest, Open, Proud for adolescents with mental illness: pilot randomized controlled trial. *Child Psychology Psychiatry*. 2018;59(6):684-691. doi:10.1111/jcpp.12853

 doi:10.20944/preprints202605.1490.v1

36. Islam MdI, Khanam R, Kabir E. The use of mental health services by Australian adolescents with mental disorders and suicidality: Findings from a nationwide cross-sectional survey. Rahman M, ed. *PLoS ONE*. 2020;15(4):e0231180. doi:10.1371/journal.pone.0231180
37. Schlosser DA, Campellone TR, Truong B, et al. Efficacy of PRIME, a Mobile App Intervention Designed to Improve Motivation in Young People With Schizophrenia. *Schizophrenia Bulletin*. 2018;44(5):1010-1020. doi:10.1093/schbul/sby078
38. Radesky J, Weeks H, Schaller A, Robb M, Mann S, Lenhart A. Constant Companion: A Week in the Life of a Young Person's Smartphone Use. *Common Sense*. Published online 2023. https://www.commonsensemedia.org/sites/default/files/research/report/2023-cs-smartphone-research-report_final-for-web.pdf
39. What Is the Digital Divide? https://www.ncbroadband.gov/
40. Atske S. Teens and Internet, Device Access Fact Sheet. *Pew Research Center*. Accessed February 5, 2025. https://www.pewresearch.org/internet/fact-sheet/teens-and-internet-device-access-fact-sheet/
41. Lenhart A. Teens, Technology and Friendships. *Pew Research Center*. Accessed February 5, 2025. https://www.pewresearch.org/internet/2015/08/06/teens-technology-and-friendships/
42. Valkenburg PM, Sumter SR, Peter J. Gender differences in online and offline self-disclosure in pre-adolescence and adolescence. *British J of Dev Psycho*. 2011;29(2):253-269. doi:10.1348/2044-835X.002001
43. Constant Companion: A Week in the Life of a Young Person's Smartphone Use | Common Sense Media. Accessed March 10, 2026. https://www.commonsensemedia.org/research/constant-companion-a-week-in-the-life-of-a-young-persons-smartphone-use
44. McBain RK, Bozick R, Diliberti M, et al. Use of Generative AI for Mental Health Advice Among US Adolescents and Young Adults. *JAMA Netw Open*. 2025;8(11):e2542281. doi:10.1001/jamanetworkopen.2025.42281
45. Maheux AJ, Akre-Bhide S, Boeldt D, et al. Generative Artificial Intelligence Applications Use Among US Youth. *JAMA Netw Open*. 2026;9(2):e2556631. doi:10.1001/jamanetworkopen.2025.56631
46. Klarin J, Hoff E, Larsson A, Daukantaitė D. Adolescents' use and perceived usefulness of generative AI for schoolwork: exploring their relationships with executive functioning and academic achievement. *Front Artif Intell*. 2024;7. doi:10.3389/frai.2024.1415782
47. Naddaf M. AI chatbots are sycophants — researchers say it's harming science. *Nature*. 2025;647(8088):13-14. doi:10.1038/d41586-025-03390-0
48. Yeung JA, Dalmasso J, Foschini L, Dobson RJ, Kraljevic Z. The Psychogenic Machine: Simulating AI Psychosis, Delusion Reinforcement and Harm Enablement in Large Language Models. *arXiv*. Preprint posted online September 17, 2025:arXiv:2509.10970. doi:10.48550/arXiv.2509.10970
49. Holmes G, Tang B, Gupta S, Venkatesh S, Christensen H, Whitton A. Applications of Large Language Models in the Field of Suicide Prevention: Scoping Review. *J Med Internet Res*. 2025;27:e63126. doi:10.2196/63126
50. Haroz EE, Kitchen C, Nestadt PS, Wilcox HC, DeVylder JE, Kharrazi H. Comparing the predictive value of screening to the use of electronic health record data for detecting future suicidal thoughts and behavior in an urban pediatric emergency department: A preliminary analysis. *Suicide Life Threat Behav*. 2021;51(6):1189-1202. doi:10.1111/sltb.12800
51. Gutierrez G, Stephenson C, Eadie J, Asadpour K, Alavi N. Examining the role of AI technology in online mental healthcare: opportunities, challenges, and implications, a mixed-methods review. *Front Psychiatry*. 2024;15. doi:10.3389/fpsyt.2024.1356773
52. Hill K. A Teen Was Suicidal. ChatGPT Was the Friend He Confided In. *The New York Times*. August 26, 2025. Accessed March 6, 2026. https://www.nytimes.com/2025/08/26/technology/chatgpt-openai-suicide.html
53. Roose K. Can A.I. Be Blamed for a Teen's Suicide? *The New York Times*. October 23, 2024. Accessed March 6, 2026. https://www.nytimes.com/2024/10/23/technology/characterai-lawsuit-teen-suicide.html
54. Lavandera RK Allison Gordon, Ed. ChatGPT encouraged college graduate to commit suicide, family claims in lawsuit against OpenAI. CNN. November 6, 2025. Accessed March 6, 2026. https://www.cnn.com/2025/11/06/us/openai-chatgpt-suicide-lawsuit-invs-vis

 doi:10.20944/preprints202605.1490.v1

55. Richins MT, Barreto M, Karl A, Lawrence N. Empathic responses are reduced to competitive but not non-competitive outgroups. *Social Neuroscience*. 2019;14(3):345-358. doi:10.1080/17470919.2018.1463927
56. Vossen HGM, Valkenburg PM. Do social media foster or curtail adolescents' empathy? A longitudinal study. *Computers in Human Behavior*. 2016;63:118-124. doi:10.1016/j.chb.2016.05.040
57. Alloway T, Runac R, Qureshi M, Kemp G. Is Facebook Linked to Selfishness? Investigating the Relationships among Social Media Use, Empathy, and Narcissism. *SN*. 2014;03(03):150-158. doi:10.4236/sn.2014.33020
58. Derks D, Fischer AH, Bos AER. The role of emotion in computer-mediated communication: A review. *Computers in Human Behavior*. 2008;24(3):766-785. doi:10.1016/j.chb.2007.04.004
59. Surveying Americans on Empathy Burnout. *NCA UW*. Published online April 7, 2022. Accessed February 5, 2025. https://unitedwaynca.org/blog/empathy-burnout-survey/
60. Deci EL, Ryan RM. *Intrinsic Motivation and Self-Determination in Human Behavior*. Springer US; 1985. doi:10.1007/978-1-4899-2271-7
61. Ryan RM, Deci EL. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*. 2000;55(1):68-78. doi:10.1037/0003-066X.55.1.68
62. Kaplan K, Salzer MS, Solomon P, Brusilovskiy E, Cousounis P. Internet peer support for individuals with psychiatric disabilities: A randomized controlled trial. *Social Science & Medicine*. 2011;72(1):54-62. doi:10.1016/j.socscimed.2010.09.037
63. Aschbrenner KA, Naslund JA, Shevenell M, Mueser KT, Bartels SJ. Feasibility of Behavioral Weight Loss Treatment Enhanced with Peer Support and Mobile Health Technology for Individuals with Serious Mental Illness. *Psychiatr Q*. 2016;87(3):401-415. doi:10.1007/s11126-015-9395-x
64. Fortuna KL, Venegas M, Umucu E, Mois G, Walker R, Brooks JM. The Future of Peer Support in Digital Psychiatry: Promise, Progress, and Opportunities. *Curr Treat Options Psych*. 2019;6(3):221-231. doi:10.1007/s40501-019-00179-7
65. Shukla S, Balaji P, McMillan IO, Avalos MRA, Nagra H, Dana Z. Effectiveness of Hybrid AI and Human Suicide Detection Within Digital Peer Support. *Journal of Clinical Medicine*. 2026;15(5). doi:10.3390/jcm15051929
66. Wadden D, August T, Li Q, Althoff T. The Effect of Moderation on Online Mental Health Conversations. *ICWSM*. 2021;15:751-763. doi:10.1609/icwsm.v15i1.18100
67. Deng D, Rogers T, Naslund JA. The Role of Moderators in Facilitating and Encouraging Peer-to-Peer Support in an Online Mental Health Community: A Qualitative Exploratory Study. *J technol behav sci*. 2023;8(2):128-139. doi:10.1007/s41347-023-00302-9
68. Dana Z, Nagra H, Kilby K. Role of Synchronous, Moderated, and Anonymous Peer Support Chats on Reducing Momentary Loneliness in Older Adults: Retrospective Observational Study. *JMIR Form Res*. 2024;8:e59501. doi:10.2196/59501
69. Mahon NE, Yarcheski A, Yarcheski TJ. Positive and negative outcomes of anger in early adolescents. *Res Nurs Health*. 2000;23(1):17-24. doi:10.1002/(SICI)1098-240X(200002)23:1%3C17::AID-NUR3%3E3.0.CO;2-K
70. Vanhalst J, Luyckx K, Van Petegem S, Soenens B. The Detrimental Effects of Adolescents' Chronic Loneliness on Motivation and Emotion Regulation in Social Situations. *J Youth Adolescence*. 2018;47(1):162-176. doi:10.1007/s10964-017-0686-4
71. Jaycox LH, Stein BD, Paddock S, et al. Impact of Teen Depression on Academic, Social, and Physical Functioning. *Pediatrics*. 2009;124(4):e596-e605. doi:10.1542/peds.2008-3348
72. Romeo RD. The impact of stress on the structure of the adolescent brain: Implications for adolescent mental health. *Brain Research*. 2017;1654:185-191. doi:10.1016/j.brainres.2016.03.021
73. Morelli SA, Lieberman MD, Zaki J. The Emerging Study of Positive Empathy. *Social & Personality Psych*. 2015;9(2):57-68. doi:10.1111/spc3.12157
74. Flick L, Dawes M, Brian A, Monsma E, De Meester A. Relationships among peer- relatedness, self-confidence, peer victimization, social anxiety and school satisfaction in American high school students. *Physical Education and Sport Pedagogy*. 2024;29(6):573-587. doi:10.1080/17408989.2022.2135692

 doi:10.20944/preprints202605.1490.v1

75. Tokunaga RS. Following you home from school: A critical review and synthesis of research on cyberbullying victimization. *Computers in Human Behavior*. 2010;26(3):277-287. doi:10.1016/j.chb.2009.11.014
76. Nixon C. Current perspectives: the impact of cyberbullying on adolescent health. *AHMT*. Published online August 2014:143. doi:10.2147/AHMT.S36456
77. Orth U, Robins RW. Is high self-esteem beneficial? Revisiting a classic question. *American Psychologist*. 2022;77(1):5-17. doi:10.1037/amp0000922
78. Martinez-Pecino R, Garcia-Gavilán M. Likes and Problematic Instagram Use: The Moderating Role of Self-Esteem. *Cyberpsychology, Behavior, and Social Networking*. 2019;22(6):412-416. doi:10.1089/cyber.2018.0701
79. Vogel EA, Rose JP, Roberts LR, Eckles K. Social comparison, social media, and self-esteem. *Psychology of Popular Media Culture*. 2014;3(4):206-222. doi:10.1037/ppm0000047