

## Parental stress apps

A systematic review of current free-of-charge apps available in the Google Play Store aiming to help parents manage stress

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## Abstract

**Background:** Parental stress encompasses the psychological and physiological distress experienced by caregivers due to the demands of the parental role. It may have adverse effects on the whole family such as child's health outcomes, and the physical and psychological health of caregivers. Mobile health (mHealth) apps have emerged as a potential solution for stress management, offering convenience, affordability, and accessibility. However, the quality of stress management apps varies, and often users do not adhere to them. Therefore is relevant to assess their quality and to what the extend they use persuasive elements so they can provide appropriate support for parents.

**Objective:** To assess the quality and the persuasive elements presented on the of free-of-charge apps in the Google Play Store that include on their goals to support parents to deal with stress.

**Methods:** A systematic review was conducted on the app store search and on 2 databases, resulting in 9 free-of-charge apps that has as one of the aims to help parents do deal with stress. The quality of the apps was assessed using the Mobile Application Rating Scale (MARS), which evaluates the aspects of engagement, functionality, aesthetics, and information quality. The apps were also analysed based on the principles of Persuasive Systems Design (PSD) framework, assessing the implementation of design elements related to primary task support, dialogue support, system credibility support, and social support. Finally, the correlation between persuasive design elements and user ratings and download statistics was calculated.

**Results:** The average MARS score across all apps was 3.9 (scale 1-5). The dimension with the best punctuation was functionality (4.2) and the lowest engagement (3.5). A total of 158 PSD elements were identified, with an average of 17 elements per app. Primary Task Support and System Credibility Support were the categories with more elements identified (n=52 and n=51 respectively). Overall, no strong correlation between the PSD elements implemented and user ratings or downloads was found.

**Conclusion:** The apps overall exhibited good quality across the MARS dimensions and diverse implementation of PSD elements. There is area for improvement in specifying a theoretical background, have scientific studies of their effectiveness and promote better user engagement.

By having more apps that excel in these areas available for free parents can potentially obtain greater benefits and develop positive ways to cope with stress.

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## **1. Introduction**

### **1.1 Parental Stress**

Parental stress is a significant phenomenon encompassing the psychological and physiological distress experienced by caregivers due to the demands of the parental role (Deater-Deckard, 2004). It is closely tied to the context of caregiving, parent-child relationships, and the broader responsibilities of parenting (Crnic & Ross, 2017). The occurrence of parental stress is notable, with numerous caregivers experiencing its adverse effects.

Parental distress can have negative consequences, impacting not only the caregiver but also the whole family. Research consistently highlights the detrimental impact of excessive parental stress on parent-child relationships, caregiver competence, and the overall quality of life for families (Cachia et al., 2005; Cousino & Hazen, 2013; Crnic & Ross, 2017; Fang et al., 2022). The systematic review by Cousino & Hazen (2013) demonstrated that heightened parenting stress is associated with adverse psychological adjustment in both children and their caregivers, leading to poorer child health outcomes. Highly stressed parents are more prone to engaging in negative parenting behaviors, such as yelling, hitting, or withdrawal, which can contribute to behavioral problems in children (Jeong et al., 2021; Suh & Luthar, 2020). Furthermore, parental stress can lead to physical and psychological health problems for caregivers, including sleep disturbances, depression, anxiety, and fatigue (Fang et al., 2021; Fang et al., 2022). Additionally, it can strain partner relationships, resulting in increased conflict, decreased intimacy, and diminished marital satisfaction (Robinson & Neece, 2015; Dong et al., 2022).

Several factors can contribute to parental stress, both related to individual characteristics and the environment. One significant source of stress is the perception of

parenting as an endless job with multiple demands and role strain (Baker et al., 2003; Deater-Deckard, 1998; Deater-Deckard, 2004; Webster-Stratton, 1990). Balancing different responsibilities such as managing multiple children with diverse needs, and addressing behavioral challenges can lead to feelings of being overwhelmed and experiencing role strain. Moreover, the lack of social support is a significant environmental influence on parental stress, enhancing feelings of isolation and disconnection from others (Fram, 2003; Seo et al., 2006). Additionally, the health of the child, especially when they have disabilities or chronic illnesses, can contribute to heightened parental stress. The severity and diversity of symptoms, as well as the behavioral and emotional problems exhibited by the child, serve as significant stressors for caregivers (Cachia et al., 2005; Cousino & Hazen, 2013; Fairfax et al., 2010; Meadan et al., 2010; Ng et al., 2021).

Regardless of the causes, parents employ various coping mechanisms to deal with stress, and not all approaches are healthy. Maladaptive coping strategies can include avoidance, denial, aggression (verbal and physical violence), isolation, overeating, and disrupted sleep patterns (Lazarus & Folkman, 1984; Roth & Cohen, 1986; Powell & Enright, 2015). Harmful coping mechanisms, such as substance use, can exacerbate the problems associated with stress, potentially leading to more severe issues (Sinha, 2001). Nevertheless, there are positive stress management strategies that individuals can adopt to effectively mitigate the challenges. These strategies include engaging in regular physical activity, effective time management, seeking social and professional support, and making time for enjoyable activities (Greenberg, 2021; Powell & Enright, 2015). Implementing healthy stress management strategies improves the well-being of parents and creates a positive environment for the entire family. Moreover, children who observe their parents practicing healthy stress management are more likely to acquire these skills, contributing to their lifelong well-being

(Cappa et al., 2011). Therefore, supportive interventions are essential in helping parents deal with stress in healthier ways.

Several approaches can effectively improve adaptive coping strategies and reduce parental stress, and they can be available in different ways. Mindfulness-based interventions can help parents focus on the present moment and reduce stress levels (Burgdorf et al., 2019; Shorey & Ng, 2021) and Positive Psychology interventions focusing on identifying and cultivating strengths and positive emotions can enhance parental well-being and resilience (Peer & Hillman, 2014; Waters & Sun, 2016). Additionally, Cognitive-Behavioral Therapy, a well-established therapeutic approach that targets maladaptive thought patterns and behavior, can assist parents in identifying the sources of stress and developing healthier coping skills (Ngai et al., 2016; Onyishi et al., 2023; Urbanowicz et al., 2023). These and other types of interventions can be offered in various settings and contexts, such as individual therapy, parenting support groups (Sharma et al., 2022; Urbanowicz et al., 2023), and internet and mobile-based interventions (Döpfner et al., 2020; Păsărelu et al., 2023; Sakamoto et al., 2022).

## **1.2 Mobile Health Support for Stress**

Online programs and interventions represent a growing field in stress management. Mobile health (mHealth) apps have been widely implemented across various health disciplines, including psychology. According to the World Health Organization (2011), mHealth refers to the use of digital technologies to support individuals in public and medical health practices. This category of applications includes self-management platforms, healthcare-specific tools, and educational materials.

The widespread and constant rise in the use of mobile devices, such as smartphones and tablets, has contributed to the integration of mobile applications into people's daily lives.

Mobile internet usage has surpassed other forms of internet access. In 2022, there were over five billion unique mobile internet users, accounting for nearly 60% of total web traffic originating from mobile devices (Statista, 2023a). In this context, mobile applications have become easily accessible means to support personal activities and improve well-being. Data from 2020 to 2021 showed that there were over 65,300 mHealth apps available to Android users via the Google Play Store alone (Statista, 2023b).

mHealth apps have the potential to revolutionize the way people manage their stress levels. These apps offer a convenient, affordable, and accessible way to help individuals regulate their emotional states, reduce their stress levels, and improve their mental health (Vertola et al., 2022; Apolinário-Hagen et al., 2019; Marzano et al., 2015). A systematic review conducted by Vertola et al. (2022) found that mHealth apps for stress management and emotional self-regulation can improve stress levels, emotional self-regulation, and work performance in adults. Specifically for parents, Păsărelu et al. (2023) assessed parents of children with attention deficit hyperactivity disorder (ADHD) regarding the use of a mobile application that aimed to reduce parental distress among other objectives. They found that most parents expressed interest in using such apps for themselves and their children and that is a promising approach that could be used complementary to treatments.

### **1.3 Assessment of quality and persuasiveness**

Even though there are studies showing positive results, the lack of standardization and regulation in the app market can lead to a proliferation of low-quality or ineffective mHealth apps, including those focused on stress management. Given the continuously growing number of mental health apps available and the fact that they can be developed by any person or company without evaluating the apps, it is important to ensure the availability of quality and effective apps. The abundance of mHealth apps can lead to confusion and frustration among

users (van Velsen et al., 2013). Additionally, it is crucial to incorporate scientific evidence and clinical expertise into the development of mHealth apps. Marzano et al. (2015) highlighted that developing effective and safe apps requires a rigorous process of testing, validation, and regulation, but unfortunately, this is not always the case. For instance, Coulon et al. (2016) evaluated 60 stress management apps for different target groups and found that 33% of them did not employ any evidence-based strategies. Furthermore, even among the apps with an evidence-based methodology, some lacked instructional support or offered incomplete or misinformed instructions.

The quality of apps can be assessed in various ways using different indicators. One standardized and well-established tool for evaluating health apps is the Mobile App Rating Scale (MARS). The MARS consists of four dimensions that capture different aspects of an app's quality: engagement, functionality, aesthetics, and information quality (Stoyanov et al., 2015).

Some apps lack quality, but moreover, many apps are not engaging enough, leading to high non-adherence. Effective user engagement is essential for the success of mHealth apps and low engagement is an increasingly recognized challenge, potentially representing a barrier the apps effectively help the users and to be implemented in mental healthcare (Serrano et al., 2017; Torous et al., 2018; Torous et al., 2019). In order to improve the (continued) use and engagement with software, Oinas-Kukkonen and Harjumaa (2019) proposed a systematic overview for developing persuasive software solutions. The model explains methods to how to transform proposed design principles into actual software requirements, enhancing the systems (including apps).

This persuasive system design (PSD) paradigm categorizes technological elements into different categories, namely as primary task support, dialogue support, social support, and credibility support. Although the model is well-known and highly used, To date, not



much is known about whether the number of persuasive design elements actually is associated with increased uptake and fewer drop out of apps usage. Therefore, analysing if and how these categories are incorporated into the apps allows for an assessment of their potential impact on adherence.

#### **1.4 Objective and Research Questions**

This study aims to create an inventory and assess the quality and the persuasive design elements present on the free-of-charge apps in the Google Play Store that include on their features support for parents to deal with stress. Therefore, it aims to answer the following questions:

What are the currently available free apps in the Google Play Store that include in their features support parents in dealing with stress?

What is the quality of these apps according to the MARS criteria?

To what extent do these apps implement the elements of each of the PSD categories?

Is the amount of PSD elements related to the apps popularity amongst users?

## 2. Methods

### 2.1 Search and Selection Process

This research included apps free-of-charge apps that include in the aims to help parents manage stress. In order to find the apps available two systematic searches were conducted: one with several keywords on the Google Play Store and the other an article search on scientific databases for articles that included apps on the scope of this study. A detailed screening of the findings was performed in order to find the apps that could be included in this research.

The apps that met the inclusion criteria had their quality and use of persuasive elements assessed. First the Mobile Application Rating Scale was applied by the author. Second the apps were analysed based on the principles of the Persuasive Systems Design framework (Oinas-Kukkonen & Harjumaa, 2009). The extent to which these principles were implemented in each app was assessed and scored accordingly in order to realize an analysis. Finally, to explore the correlation between the number of persuasive design elements and the popularity of the apps, the download statistics and user ratings from the Google Play Store were examined. The Spearman correlation coefficient was used to determine the correlation between the average rating of an app, the number of downloads and the persuasive design elements implemented.

#### *2.1.1 Play Store Search*

The aim of this search was to identify English-language, free-of-charge apps available on the Google Play Store that aimed to help parents manage stress. The Play Store was chosen because of the wide adoption of the Android mobile operating system, which holds approximately 71% of the market share worldwide (Statista, 2023c). Additionally, the Google Play Store offers a higher number of free apps compared to its main competitor, the Apple

Store. As of March 2023, 97% of apps in the Google Play Store were freely available, while the percentage of free apps in the Apple Store was 82% (Statista, 2023d).

To minimize bias, the search was conducted on a desktop without any associated Google profile account. The results were limited to 30 apps due to the restrictions of the Play Store searches, and no filters or options were available to refine or expand the results. The researcher made several attempts to expand the number of results, including contacting Play Store support, seeking assistance from the University of Twente's information specialist, and consulting the University of Twente's Methodology shop. However, none of these support services were able to help to expand the number of results.

The initial list of apps was obtained through a keyword search on the Google Play Store between April 27<sup>th</sup> and 28<sup>th</sup>, 2023. The following keywords were used: "caregiver apps", "caregiver stress", "caregiving", "dad mental health", "dad wellness", "mental health caregiver", "mental health parents", "mom mental health", "mom wellness", "parenting", "parents stress management", "parents wellness", "stress management caregiver", "stress parents". The search results were automatically prioritized by the Play Store based on relevance, engagement, and app quality. It was not possible to change these priorities or obtain different results. The search results can be found in Appendix A.

Data from the search results were collected using a web crawler (ParseHub), the search results were collected using a web crawler (ParseHub), a search engine that downloads and indexes content from the solicited internet pages, and organized in an Excel spreadsheet (Appendix B). The extracted data for each app included the app's name, URL, developer, and description and this information was used to perform the analysis of inclusion/exclusion of each app. The analysis of the apps was based on their descriptions and screenshots available on the Play Store webpage.

Since 14 different keywords were used, a total of 420 apps were initially found, of which 199 were duplicates and 221 remained for analysis (Refer to figure 1 for the whole schematic representation of the selection process for apps). The inclusion criteria were as follows: (1) available in English, (2) free of charge, (3) targeting at least one parent, and (4) including features that aims to help parents manage stress or improve their wellness. Out of the remaining 221 apps, 206 did not meet the inclusion criteria, leaving 15 apps for further analysis. The reasons for exclusion included apps mentioned for caregivers other than parents or for the care of chronic conditions (n=36), apps for mental health and wellness not specific to parents (n=79), apps specific to parents but without a focus on stress management (n=53), apps not in English (n=1), games (n=23), and apps with purposes other than parenting or stress management (n=14). Following the application of the selection criteria, a total of 15 apps were included in the analysis.

### ***2.1.2 Article Search***

To identify additional apps that met the inclusion criteria, a search of relevant articles was conducted. The goal was to identify articles that discussed apps designed to support parents and included information about the apps that could be included in the analysis. The search was conducted on April 24th using the Scopus and PubMed databases. The search string used was as follows: parent\* OR caregiver\* OR carer OR mother OR mom OR dad OR father AND stress\* OR mental health OR burden AND app OR mobile application\* OR mobile.

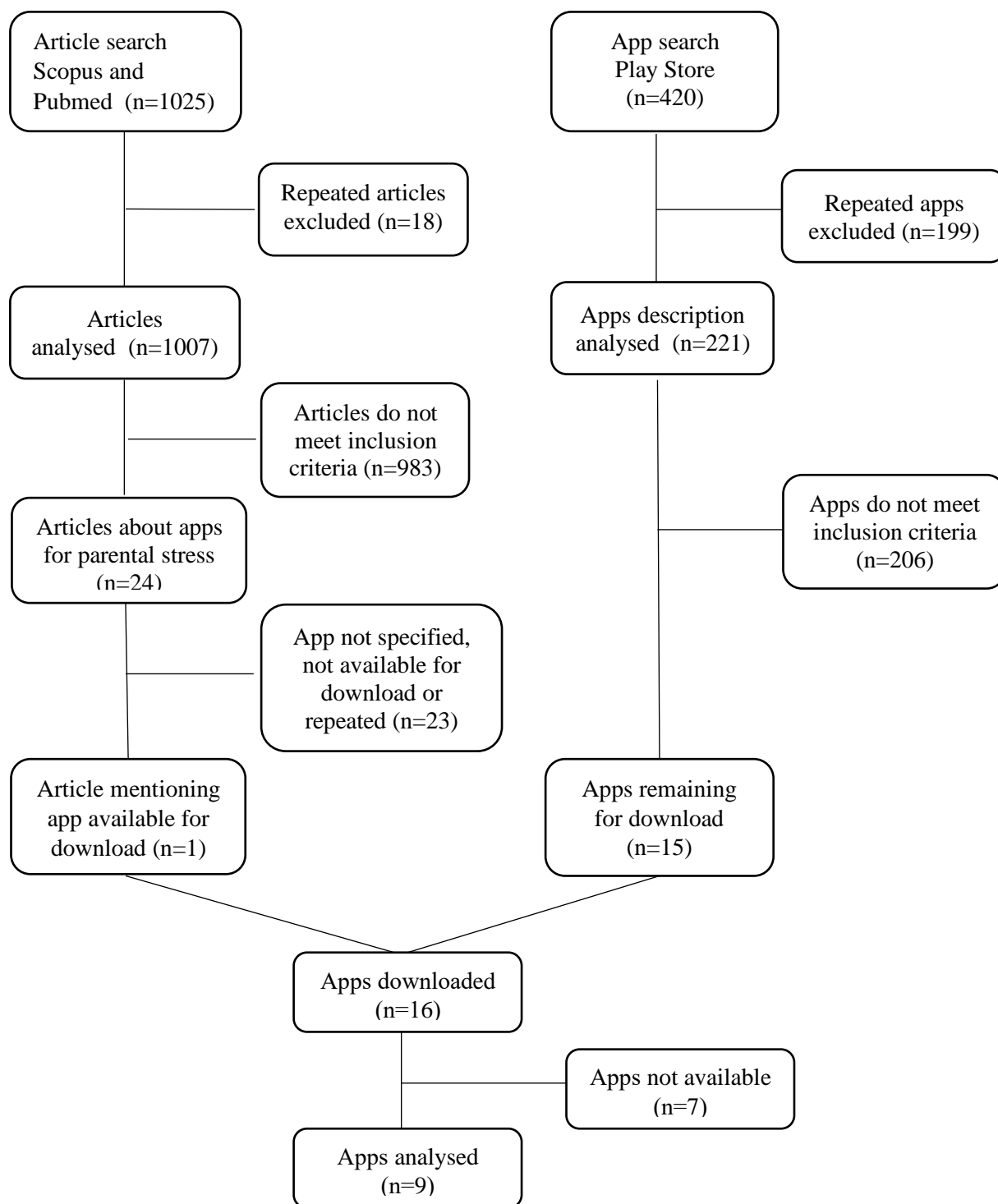
The search yielded 892 results in the Scopus database and 133 results in PubMed, resulting in a total of 1025 articles, with 18 duplicates. The remaining results were evaluated in two different phases. First analysis had the following criteria: (1) availability in English, (2) study including mobile app usage, (3) target population comprising at least one parent, (4) app specifically designed for parents, and (5) app including features to help parents manage stress

or improve their wellness. Out of the 983 articles that did not meet these criteria, 24 articles were selected.

Second phase was the detailed analysis of the 24 articles that met the inclusion criteria previously mentioned. From them, 22 articles were excluded due to the following exclusion criteria: article did not mention the names of the apps or used prototypes (n=11); app was not available on Google Play Store (n=11). The only app available on the Google Play Store was the “Supportive Parenting App”, was referenced in two articles (Shorey et al., 2023; Shorey et al., 2023b). Therefore, this app was included in the analysis, resulting in a total of 16 apps for analysis.

During the download phase, seven apps that initially met the selection criteria could not be analyzed due to the following reasons: no free access available (n=3), no registration available for new users (n=2), and unavailability for download in the researcher’s current geolocation (n=2), remaining 9 apps for evaluation. Figure 1 presents a schematic representation of the selection process for apps and scientific articles.

**Figure 1** Flowchart of the inclusion process for article and app search



## 2.2 App Evaluation

### 2.2.1 Mobile Application Rating Scale

The Mobile Application Rating Scale (MARS) was used to assess the quality of the apps by employing a set of specific items. The MARS consists of four main subscales: engagement, functionality, aesthetics, and information quality. Each dimension of the MARS is measured using a set of specific items that are rated on a 5-point Likert scale. The coding was performed by one researcher (the author) and the overall app rating was calculated by averaging the scores across the four dimensions (Stoyanov et al., 2015).

The *engagement* dimension comprises five items and assesses the overall appeal of the app, its entertainment value, and the level of user involvement. The *functionality* dimension includes four items and focuses on the app's technical performance, including usability and navigation. The *aesthetics* dimension consists of three items and rates the visual appeal of the app, such as its design, layout, and graphics. Finally, the *information quality* dimension comprises seven items and assesses aspects such as the accuracy of app descriptions, goals, credibility, and evidence base. All apps included in this research were rated in each category using the provided questions and reference for scoring (refer to Appendix C).

### 2.2.2 Persuasive Systems Design (PSD)

As previously explained, the design principles of the Persuasive Systems Design framework developed by Oinas-Kukkonen and Harjumaa (2009) provide a systematic overview for developing persuasive software solutions. This framework consists of 28 design principles organized into four categories: primary task support, dialogue support, system credibility support, and social support.

*Primary Task Support* refers to features that are directly related to the primary purpose of the system, such as providing information or completing tasks, aiming to make the system

more effective and efficient at achieving its primary goal. The features in the *dialogue support* category have the goal of establishing a positive and engaging dialogue between the user and the system, which can increase the user's motivation. These features may include various forms of interaction, such as feedback, suggestions, reminders, and personalized messages. The goal of the *system credibility* support is to enhance credibility and trustworthiness, establishing a strong and positive reputation, which can increase the user's confidence in the system's persuasive messages and recommendations. Finally, the *social support category* aims to leverage the person's social environment to increase their motivation, confidence, and commitment to achieving goals. The features may include various forms of social interaction, such as peer support, social sharing, and social comparison (Oinas-Kukkonen & Harjumaa, 2009).

Each app included in this research was analysed to determine which of the 28 elements were implemented and to what extent they were present. A score was calculated to give different points depending on whether a principle was applied. The apps were ranked as follows: not implemented (score = 0), element partially implemented (score = 1), and implemented (score = 2).

By grading the extent to which a principle was applied, a more accurate score could be achieved as some PSD features were implemented to a rather limited extent compared to the criteria established by Oinas-Kukkonen & Harjumaa (2009) and in comparison, to how they are present in other apps. For example, in terms of recognition (an item in the social support category), according to the authors, "*a system should provide public recognition for users who perform their target behaviour*" (p.495), such as naming and publishing the best achievers of a certain goal on the website or platform. The apps analysed do not present a feature from the system as described, but in some apps, users can provide recognition through



comments or likes. Therefore, it was considered partially implemented, as having the mentioned feature available cannot be considered as having no recognition at all in the app.

In cases of dilemma, the item was left for analysis as the last one, and the usage of the element was compared to how it was clearly or partially implemented in other apps. If needed, examples of how it was classified in other research (Wintermeyer, 2021) were used for comparison as well.

### ***2.2.3 User Ratings Evaluation***

To investigate if there is a correlation between the number of persuasive design elements and the popularity of the apps, the download statistics and user ratings of the apps in the Google Play Store were examined. In the Google Play Store, users can give ratings ranging from 1 to 5 stars. The average rating of an app and the number of downloads can be viewed on the app store website. The Play Store does not provide the exact number of downloads but indicates a range. For instance, an app that has been downloaded more than 100,000 times is indicated as 100K+. For the purposes of this research, the main number was considered.

## **2.3 Data Analysis**

Trends and relationships were identified through descriptive analyses. The Spearman correlation coefficient was used to assess the non-linear associations between PSD elements used, number of downloads and user ratings. The hypothesis was that the number of persuasive elements implemented on the apps would be correlated with popularity, either through having more downloads or having better user ratings.

### **3. Results**

From the 9 apps analysed, 3 targeted fathers (Dadditude, DadPad, and How to be a good dad), 3 targeted mothers (Expectful, Mindful Mamas, and Mental Health for Mom + Social), and the remaining 3 targeted parents in general. Only two apps had the main focus of promoting wellness and reducing stress (Expectful and Mindful Mamas). All other apps had broader goals such as promoting social connection and teaching parenting skills, and they included mental health promotion in their content. A short description of the apps copied from the app's page on Google Play Store, user's rate and number of downloads is available in Table 1.

**Table 1** Apps names, developers and description.

App name as in app store	Developer	User's Rate	N downloads	Brief description
DadPad	DadPad	3.3	10000	An essential guide for new dads, supporting new families in working together for their babies. New dads will feel excited, but may also feel left out, unsure, and overwhelmed. The Dadpad gives dads-to-be the knowledge and practical skills necessary to support themselves and their partner, so that babies get the best possible start in life.
Expectful: Wellness for Moms	Expectful Inc.	4.5	50000	Meet Expectful: a haven of holistic care for fertility, pregnancy, and motherhood. For the healthiest, happiest moms and babies, women need more than prenatal vitamins and ultrasounds. They need care. Truly empowering, anxiety-reducing, community-building care.
How To Be A Good Dad (Father)	How to Tips and Tricks	N/A	500	From pregnancy and childbirth to good parenting, we're breaking down How To Be A Good Dad with some of the most important questions about this happening in society.
Manatee: Family Mental Health	Manatee, Inc.	4.5	1000	Manatee is here to help your family grow closer together and thrive! We empower parents and kids with resources to learn more about each other, build healthy habits, tools to cope with big feelings, and connect more deeply.
Mental health for mom + Social	Social.mom	4.3	100000	Social Mom is THE all mom community where you can be yourself, talk about real stuff, have fun and relax. Meeting other moms with similar interests is easier than ever now!
Mindful Mamas: Sleep for Moms	Mindful Mamas Club	4.8	100000	Mindful Mamas is a self-care and mindfulness app made specifically for moms and moms-to-be. Get support to manage stress, anxiety, and sleep by using the FREE version, or select an upgrade for access to the full library.
Parenting App Dadditude	Dadditude	4.7	10000	In just a few minutes, reflect, grow and connect with your most important role. We know you want to be a great Dad. But we also know how tough, stressful, and complex it is to feel like you are doing a great job. Dadditude is the app for becoming a happier, more confident father.
Parents	All About Parenting	4.8	100000	Learn how to be the best mommy or daddy you can be for your child with our live seminars and premium programs.
The Happy Child Parenting App	HJB Ventures	5	500000	Our daily lessons will help you manage parental information overload by giving you science-based ways to increase the long-term happiness of your child. These short, easy-to-understand lessons can be implemented immediately to improve your family life no matter the age of your child(ren).

### 3.1 MARS

The average MARS score for all 9 apps is 3.9 (Table 2). The highest-scoring app is Parenting App Dadditude, with an overall score of 4.3. The other best scoring apps had a very close overall score, both apps Mindful Mamas and the Happy Child App had an score of 4.2. The lowest-scoring app is How To Be A Good Dad, with an overall score of 2.8, with a gap of 1 point to the next lowest score, by the app Mental Health for Mom + Social (3.8). Even though the average MARS of score is 3.9 there are some differences in the dimensions. The details of the punctuation of each MARS category are available on appendix D.

**Table 2** MARS scores by dimension

App	Engagement	Functionality	Aesthetics	Information Quality	Overall Score
Dadditude	4.0	4.8	4.3	4.2	4.3
Mindful Mamas	3.6	4.5	4.7	4.2	4.2
The Happy Child	4.0	4.3	4.3	4.2	4.2
DadPad	3.4	4.5	3.7	4.3	4.0
Manatee	3.6	4.0	4.3	4.2	4.0
Expectful	3.6	4.3	4.0	4.0	4.0
Parents	3.6	4.3	3.7	3.5	3.8
Mental health for mom + Social	3.6	3.5	4.0	3.4	3.6
How to be a good dad	2.2	4.0	2.7	2.5	2.8
Mean (range)	3.5 (2.2-4)	4.2 (4.0-4.8)	4.0 (2.7-4.7)	3.8 (2.5-4.2)	3.9 (2.8-4.3)

#### 3.1.1 Engagement

The mean score for the "engagement" dimension among all apps is 3.5, representing that the apps analyzed have a moderate level of engagement. This is the lowest mean result of all the dimensions. Two specific criteria of the MARS, namely customization and fun,

contributed to low the average (detailed scores can see on Appendix D). The mean score of the item “customization” score were low (2.7) as all apps just allow basic customization, except for “How to be a good dad” that does not allow any kind of customization. The other criteria with low average score (3.3) is “fun” as just the free features were considered, most apps are fun enough to entertain for a brief (less than 5 minutes) or some time (5 to 10 minutes). The highest-rated apps in terms of engagement are Dadditude and The Happy Child, both receiving a score of 4.0. These apps are more likely offer a compelling user experience and interactive features. Conversely, How To Be A Good Dad scored the lowest with a score of 2.2, lacking interactive features.

### ***3.1.2 Functionality***

The app Dadditude received the highest functionality score of 4.8, followed by Mindful Mamas and DadPad, both scoring 4.5. The app Mental health for mom + Social received the lowest functionality score of 3.5 among the listed apps, mainly due the fact that the app still offers video-options that the user cannot access. Except for this app, all others app have scores equal or superior to 4 points and a mean of 4.2, indicating they are likely to have a solid set of features and provide a good user experience.

### ***3.1.3 Aesthetics***

Aesthetics is the dimension with the largest gap between the highest score app (Mindful Mamas with 4.7 points) and the app with the lowest score (How to be a good dad, with 2.7 points). The first app has a very professional and clear layout with a very memorable use of color. The last one has little visual appeal, being visually boring. In total, 6 out of 9 apps received scores ranging from 4.0 to 4.7, an indication of high quality of the visual appeal, graphics and layout of these apps.

### ***3.1.4 Information quality***

The app DadPad has the highest score of 4.3. The main reason why this app got the highest score is because it is the only one to score 5 points on the subcategory “credibility”, being the only app developed by a national government institution (NHS in UK). Other four apps had a similar score, being the second best ranked with 4.2 points (Dadditude, Mindful Mamas, The Happy Child and Manatee). The app How to be a good dad received the lowest score (2.5) for information quality, indicating that the app is below average in terms of providing accurate and relevant information to its users.

This subitem “quality of information” of this dimension also included mentioning which theoretical background the apps was based. Even though most apps mentioned being scientific based or based on research, they lack to indicate an specific approach, limiting to refer to big areas of study such as Psychology or Pedagogy. Only two apps clearly identified a specific background (Mindful and Expectful), both based on mindfulness. Nevertheless, not specifying a theoretical background did not influence the score as it was based on the information being relevant appropriate, coherent and correct which occurs besides of that information being explicit to the users.

Another evaluating subcriteria of this dimension concerns the evidence-base of the apps. The scores vary from 1 in case evidence suggests the app does not work until 5 if the app has been trialed and outcome tested in 3 or more RCTs indicating positive results (as can seen on Appendix D). If the app has not had being evaluated the item is marked as non applicable (N/A). The author could not find any RCT for the apps included on this study, meaning that all of them were marked as N/A and that did not affect the score of this dimension.

### 3.2 Persuasive Design elements

A total of 158 Persuasive System Design elements were identified within the 9 apps, with the mean of 17 elements per app. The table 3 presents an overview how many elements are presented in each category and how many each app used. The app Dadditude is the one that presents more elements (n=22) and How the be a Good dad the one with the least (n=7). It is worth noticing that having the highest amount of elements implemented does not reflect in the highest punctuation, meaning that an app can have less elements present but they were mostly fully implemented. That is the case of the app Expectful, that has 17 of the 20 elements fully presented and a punctuation of 37, higher than the app Manatee that scored 36 points with 22 elements and the same as the app Dadditude that achieve that same score with 22 elements present.

**Table 3** PSD elements implemented and scores

App	Primary Task Support		Dialogue Support		System credibility		Social Support		n total elem.	total score (0-56)
	n elem.	score (0-14)	n elem.	score (0-14)	n elem.	score (0-14)	n elem.	score (0-14)		
Mindful Mamas	7	13	5	10	7	14	2	2	21	39
Dadditude	6	8	4	7	6	12	6	10	22	37
Expectful	7	13	4	8	7	14	2	2	20	37
Manatee	7	10	7	13	7	12	1	1	22	36
Parents	7	10	4	8	6	12	2	3	19	33
The Happy Child	6	9	4	8	6	12	2	2	18	31
Mental health for mom + Social	5	6	3	4	4	4	6	9	18	23
DadPad	4	6	1	2	6	12	0	0	11	20
How To Be A Good Dad	3	5	1	1	2	2	1	1	7	9
<b>TOTAL</b>	<b>52</b>	<b>80</b>	<b>33</b>	<b>61</b>	<b>51</b>	<b>94</b>	<b>22</b>	<b>30</b>	<b>158</b>	<b>265</b>

### 3.2.1 Primary Task Support

All elements of the primary task support category were identified in the apps, being used 52 times and with a score of 80. Table 4 details the number of elements used by each app and how often an element is presented on the apps analysed. The principle "reduction" was the only one used to its full extent in all apps (n=9) with a score of 18, so each app had clear and simple usage and functions. The elements "tunnelling" and "tailoring" were also present in some extent in all apps (n=9), however not always fully implemented (scoring 16 and 9 respectively). "Rehearsal" was the least used principle, present in only 4 apps and with a score of 6. The app Expectful incorporates the largest number of features achieving the highest score possible (s=18). How to be a good dad is the app with least elements, using only 3 fully.

**Table 4** Use of Primary Task Support Elements

APP	Reduction (0-2)	Tunnelling (0-2)	Tailoring (0-2)	Personalization (0-2)	Self-monit. (0-2)	Simulation (0-2)	Rehearsal (0-2)	Total Score (0-14)	n used elem. (0-7)
Expectful	2	2	1	2	2	1	2	12	7
Mindful Mamas	2	2	1	2	2	1	2	12	7
Parents	2	2	1	1	1	1	1	9	7
Manatee	2	2	1	1	2	1	1	10	7
The Happy Child	2	2	1	1	1	2	0	9	6
Dadditude	2	2	1	1	1	1	0	8	6
Mental health for mom + Social	2	1	1	1	1	0	0	6	5
DadPad	2	2	1	1	0	0	0	6	4
How To Be A Good Dad	2	2	1	0	0	0	0	5	3
Total	18	17	9	10	10	7	6	77	52
n elem. was used	9	9	9	8	7	6	4	-	-

Note: "elem." indicates the PSD elements



### 3.2.2 Dialogue Support

Dialogue Support elements were implemented in 33 instances within the apps (refer to table 5). Liking was the most commonly used element across the apps (n=9) and with a score of 17, meaning that just one app did not use it to its full extent. Similarity was the least present feature (n=2) with a score of 3. The app Manatee is the only app that incorporated all elements (n=9) and has the highest score (13) and the app How to be a good father does not fully utilize any element with just a score of 1.

**Table 5** Use of Dialogue Support Elements

APP	Praise (0-2)	Rewards (0-2)	Reminders (0-2)	Suggestions (0-2)	Similarities (0-2)	Liking (0-2)	Social Role (0-2)	Total Score (0-14)	n used elem. (0-7)
Manatee	2	2	2	2	1	2	2	13	7
Mindful Mamas	2	0	2	2	2	2	0	10	5
Expectful	2	0	2	2	0	2	0	8	4
Parents	2	0	2	0	0	2	2	8	4
The Happy Child	2	0	2	2	0	2	0	8	4
Dadditude	1	0	2	2	0	2	0	7	4
Mental health for mom + Social	1	0	1	0	0	2	0	4	3
DadPad	0	0	0	0	0	2	0	2	1
How To Be a Good Dad	0	0	0	0	0	1	0	1	1
Total	12	2	13	10	3	17	4	61	33
n elem. was used	7	1	7	5	2	9	2	-	-

Note: "elem." indicates the PSD elements

### 3.2.3 System Credibility Support

System Credibility Support is the second category where the elements were most frequently identified (51). This category also achieved the highest score (s=94) meaning that it has the largest number of elements integrated to its full extent. Table 6 details how often each element is present and the number of elements the apps integrated. Most of the apps have similar levels of trustworthiness, expertise, surface credibility, real-world feel and

authority , except for Mental Health for mom and How to be a good dad. The apps Expectful and Mindful Mamas both fully utilize all the elements listed in the System Credibility Support group. How to be a good dad lack integration of most of elements, having used just 2 of them partially.

**Table 6** *Use of System Credibility Elements*

APP	Trust Worth. (0-2)	Exper Tise (0-2)	Surf. Credib (0-2)	RWF (0-2)	Authority (0-2)	TPE (0-2)	Verifia bility (0-2)	Total score (0-14)	n used elem. (0-7)
Expectful	2	2	2	2	2	2	2	14	7
Mindful Mamas	2	2	2	2	2	2	2	14	7
Dadditude	2	2	2	2	2	0	2	12	6
Manatee	1	2	2	2	1	2	2	12	7
The Happy Child	2	2	2	2	2	0	2	12	6
DadPad	2	2	2	2	2	2	0	12	6
Parents	2	2	2	2	2	2	0	12	6
Mental health for mom + Social	1	1	1	0	1	0	0	4	4
How To Be a Good Dad	1	0	1	0	0	0	0	2	2
Total	15	15	16	14	14	10	10	94	51
n elem. was used	9	8	9	7	8	5	5	-	-

Note: "elem." indicates the PSD elements. RWF: Real World Feel. TPE: third part endorsement

### 3.2.4 Social Support

Social Support is the category with the least number of elements integrated (n=22) and a total of 30 in the score. The total amount of elements in each app and in each category can be seen on table 7. Social Comparison is the most common element, 8 apps incorporate it partially, feature that occurs thanks to the possibility of sharing the content straight on the user's social media. The element competition is the only one that is not present in any app. The app Dadditude integrates the most elements, 4 used fully and 2 partially. The DadPad app is the only that did not incorporate any of the elements and this is the only category that the app how to be a good father is not the with the least used of elements.

**Table 7** *Use of Social Support Elements*

APP	Social Learn. (0-2)	Social Comp. (0-2)	Norm. Influen (0-2)	Social Facilit. (0-2)	Cooper ation (0-2)	Compe tition (0-2)	Recog nition (0-2)	Total Score (0-14)	n used elem. (0-7)
Dadditude	1	1	2	2	2	0	2	10	6
Mental health for mom + Social Parents	1	1	2	2	2	0	1	9	6
Expectful	0	1	1	0	0	0	0	2	2
Mindful Mamas	0	1	1	0	0	0	0	2	2
The Happy Child	0	1	1	0	0	0	0	2	2
How To Be a Good Dad	0	1	0	0	0	0	0	1	1
Manatee	0	1	0	0	0	0	0	1	1
DadPad	0	0	0	0	0	0	0	0	0
Total	2	8	9	4	4	0	3	30	22
n elem. was used	2	8	6	2	2	0	2	-	-

Note: “elem.” indicates the PSD elements

### 3.2.5 PSD elements and User Ratings Evaluation

The total number of downloads and ratings given by the user’s are presented on Table 1. The app Happy Child has the highest number of downloads (over 500000) and the best score among users (5 stars). Except for the apps Mental health for mom +Social and DadPad, all apps have a score equal or higher to 4.5, indicating good evaluations. The app with worse review is DadPad, and most of the low reviews (1 star) the users were complaining about the information being limited to specific regions. The app with the least number of downloads, How to be a good dad, was the only one without user’s rate.

Spearman’s rank-order correlation were run to examine the relationship between the number of downloads, user’s rate and the number of persuasive elements (total and of each category). In order to have a more precise correlation, the number of downloads were grouped in 4 different groups encompassing a different range of total downloads: Apps with 1.000 downloads were rated as 1, apps with 10.000 up to 50.000 downloads rated as 2, apps with 100.000 downloads rated as 3 and apps with 500.000 downloads rated as 4.

The results are presented on table 8 and the correlation between the different PSD categories and the total amount of elements was not presented as it is not relevant for the current study. As the app How to be a good dad did not have a rating available on the app store it was not included.

**Table 8** Overview of Spearman's correlations between the number of the PSD elements used by the app (N=8) , app rates and number of downloads

Elements used	Subjective User Ratings		Number of downloads	
	$r_s$	$p$	$r_s$	$p$
1. Total persuasive design elements	.305	.463	-.393	.336
2. Primary Task Support	.478	.231	-.121	.776
3. Dialogue Support	.513	.193	-.187	.658
4. System Credibility Support	.165	.696	-.439	.277
5. Social support	.226	.590	.376	.359

Note: No correlation was significant at the 0.05 level

The correlation presented should be carefully considered, as the information of just 8 apps were analysed. None of the presented correlations were statistically significant. There were however weak associations between the total number of PSD elements the average user ratings ( $r_s=.305$ ,  $p=.463$ ) and the number of downloads ( $r_s=-.393$ ,  $p=.336$ ). Specific categories also lack strong correlations, with the most significant among them being Dialogue Support elements used and user ratings ( $r_s=.513$ ,  $p=.193$ ) and Primary Task Support elements and user rating ( $r_s=.478$ ,  $p=.231$ ), both considered moderately positive. All correlations of the number of downloads and the PSD elements are negatively correlated with exception of the social support elements used ( $r_s=.376$ ,  $p=.359$ ), and none presented a statistically significant association. The strongest correlation was found between the average user ratings and the number of downloads ( $r_s=.608$ ,  $p=.110$ ), representing a moderate correlation.

## **4. Discussion and Conclusions**

As parental stress is a noteworthy concern that can yield negative outcomes for caregivers and their families, it is fundamental to ensure that parents have access to tools that facilitate effective coping mechanisms. While mHealth apps are an accessible opportunity for assisting individuals in regulating their stress levels, it is crucial to assess if the available options deliver quality and appropriate support to their users.

The objective of this study was to evaluate the quality and the use of persuasive design elements on free apps available in the Google Play Store that include features aiming to support parents in dealing with stress. After an extensive search on the Play Store and review of scientific articles on the topic, 9 apps met the inclusion criteria and were assessed according to the Mobile App Rating Scale tool and the implementation of Persuasive System Design elements.

### **4.1 Evaluation of the MARS Scores**

Overall, the parenting apps evaluated were of good quality, with MARS scores, an average of 3.9, which is comparable to scores found in other reviews of apps for mental health, stress management, or mindfulness (Lau et al., 2021; Schultchen et al., 2020; Weekly et al., 2018; Wintermeyer, 2021).

In the engagement dimension, the mean score of 3.5 indicates a moderate level of engagement and is the lowest average among all four dimensions. This finding aligns with previous research indicating that mobile applications struggle to consistently capture and maintain users' attention (Domhardt et al., 2021; Kaveladze et al., 2022; Melcher et al., 2020). Although the item "fun" received the lowest score, it is important to consider that the goal of these apps is to help parents improve their mental health and perhaps provide fun is not a feature that needs to be included nor parents expect to find it on the apps. Additionally, the

item "customization" also contributed to the low average score, and it is an important factor in increasing the effectiveness of mHealth interventions (Gosetto et al., 2020). It is relevant to highlight that this study evaluated only the free features available on the apps. As some apps present more features once the user pays for them, that means that they potentially provide engagement for a longer period, therefore would have a better score on this dimension.

More positive results were found in the functionality dimension (score of 4.2) in which all apps scored equal to or above 4.0, except for the Mental Health for Mom + Social app. This suggests that the evaluated apps generally offer a solid set of features and provide a satisfactory user experience in terms of performance, navigation, gestural design, and ease of use. Good functionality elements are important for a reduced cognitive load when interacting with apps (Austin et al., 2022) and when users find the apps useful and easy to use, they are more likely to accept them (Apolinário-Hagen et al., 2019).

In the aesthetics dimension, 6 out of the 9 apps received scores above 4.0 to indicating that the majority excel in terms of aesthetics. Interestingly, the majority of this high scored apps offered in-app purchases. That might suggest that apps that also aim profits might invest more on the aesthetic quality. Investing on this dimension might be important to mhealth apps as it has been shown that design aesthetics significantly affects customer trust and perceived usefulness on apps (Chaouali et al., 2019; Li & Yeh, 2010).

The information quality dimension was the second lowest score among all (3.8) nonetheless it was higher than what was found in other similar studies including mhealth apps (Carrouel et al., 2022; Wu et al., 2022). Two main issues were identified within this dimension: the lack of specification on the theoretical background and the lack of evidence base studies.

Most apps mention that they are based on broad fields such as Psychology or Pedagogy without identifying a specific theoretical approach, or mention "scientific research"

without providing specific details. Only two apps, Mindful Mamas and Expectful, specified a theoretical background based on mindfulness. Based on the use made by the author, it is possible to affirm that both apps actually were developed taking into consideration the underlying theoretical framework. That is relevant since research shows that mindfulness-based interventions are helpful for parents focus reduce stress levels (Burgdorf et al., 2019; Shorey & Ng, 2021).

It is worth to highlight that the incorporation of theoretical and scientific components in technological health interventions yields positive effects on user motivation and outcomes (Donker et al., 2013) and that there are interventions with theoretical backgrounds other than mindfulness that have been proved helpful to parental stress such as Positive Psychology and Cognitive-Behavioral Therapy (Ngai et al., 2016; Onyishi et al., 2023; Peer & Hillman, 2014; Urbanowicz et al., 2023; Waters & Sun, 2016). Nevertheless, other apps should incorporate these and other scientific backgrounds in order to provide a wider range of alternatives so parents could find the ones that best suits their needs.

When the apps did not have a published randomized controlled trial (RCT) to prove their efficacy the item was classified as "not applicable," meaning it did not interfere on the score of this dimension. If a low score was assigned for not having a scientific based study, this dimension score would be much lower. That indicates that this score should be considered with caution and that perhaps the MARS assessment for lacking RCT should be different to realistic reflect that the apps do not have studies verifying their efficacy.

None of the apps had a published RCT which is consistent with other studies that also found a lack of RCTs for mental health apps (Carrouel et al., 2022; Domhardt et al., 2021). It is important to note that although RCT articles were found during the search phase, it was not possible to analyse any corresponding apps as they were either not mentioned or were no longer available for download or registration. This indicates a discrepancy between scientific

research evaluating mental health apps and the accessibility of those apps to general users. This might indicate that even though there is scientific investment aiming to develop quality mhealth apps, the target population is not being able properly access them, therefore the users need to rely on the apps available on the app stores.

As presented, the apps available for user download lack scientific studies, meaning that the users might not have the benefits that they expect from using this kind of support. Popular apps should have scientific studies about their efficacy as their users should have more assurance of their benefits. Bridging this gap requires collaborative efforts among researchers, developers, and policymakers to ensure that evidence-based apps are made widely available to the public.

#### **4.2 Evaluation of the implementation of Persuasive System Design elements**

The use of Persuasive System Design elements (Oinas-Kukkonen & Harjumaa, 2009) are expected to influence the effectiveness and adherence of app usage. Overall, a good implementation of PSD elements was found within the analysed apps, with variations in their implementation across the four categories.

The most implemented category of elements was related to Primary Task Support, with the "reduction" principle being identified to a large extent in almost all apps, ensuring that each app had clear and simple usage and functions. This finding aligns with other studies that also identified this group as the most popular among apps (Matthews et al., 2016; Pit et al., 2022; Sittig et al., 2020). Nonetheless, the underutilization of the "rehearsal" principle, present in only 4 apps, indicates missed opportunities to provide users with opportunities for practice and skill-building, which could enhance parents' confidence and competence in stress management.



Among the dialogue support elements, the results indicate a positive reinforcement strategy employed by the apps to motivate users and provide support. However, the limited inclusion of elements such as “similarity” suggests potential room for improvement. By emphasizing similarities between users and providing a sense of relatability, apps can foster a stronger sense of community and connection among parents. “Rewarding” could also be further explored as form of motivation for parents as rewards are likely to have beneficial effects in increase motivation (Hidi, 2015).

Social support elements were the least integrated category, fully present only in apps that have the main or one of the main objectives of creating a network among users. This suggests that the integration of social support elements depends on the app's focus on connection. As previously stated, feelings of isolation and disconnection from others contributes to parental stress (Fram, 2003; Seo et al., 2006). Considering the social support category is the one with least elements implemented, it seems that this area it hasn't receive much attention on the mhealth apps for parent. Investing in apps that will enhance the social support and the connection feeling might be a helpful support to tackle this environmental factor of parental stress.

Finally, system credibility support elements were consistently integrated across most apps, except for Mental Health for Mom + Social and How to be a Good Dad. The inclusion of elements such as trustworthiness, expertise, and authority suggest an awareness of the importance of building users' confidence in the app's content and recommendations. However as previously highlighted on the MARS assessment, the lack of specification of theoretical framework and scientific studies is an issue that need to be addressed and that would increase the aspects such as trustworthiness, expertise of the apps in the PSD elements incorporation.

Incorporating design principles in an app should enhance its attractiveness to users, potentially influencing its popularity and user satisfaction. However, the analysis of

correlations revealed weak associations between the number of PSD elements and the number of downloads or the average user ratings. These weak relationships indicates that the incorporation of design principles in an app do not enhance its attractiveness in a way that is reflected on its popularity and user satisfaction. However, it is worth noting that the app with the lowest number of implemented PSD elements, How to be a Good Dad, also has the lowest number of downloads and lacks user ratings, indicating its low popularity.

Based on the findings of this research, it is not possible to establish a substantial correlation between app popularity (measured by downloads and user ratings) and the number of implemented PSD elements, not in its totality or in the different categories. This finding is somewhat surprising as the author would expect that incorporating more PSD elements, mainly for the primary task support and system credibility support categories, would lead to a more attractive app, hence it would have greater popularity. These categories were expected to be more influential than others or than the total amount of elements used as they aim, respectively, to make the system more effective and efficient and to enhance its credibility and trustworthiness. One possible explanation for the absence of strong associations is that users' preferences and perceptions of app quality are influenced by multiple factors beyond the ones that the PSD elements have some influence.

To the best of the researcher knowledge, no previous studies have compared these factors. However, Wu et al. (2021) found a negative association between PSD features and user engagement in mental health apps, as measured by study completion rates. More attention to this subjective should have been given in future research, such as exploring which specific PSD contribute to app attractiveness. These could be done using qualitative research methods so it might be easier to identify the underlying motivations and preferences driving the satisfaction of parents using these apps. Lastly, the moderate positive correlation between user ratings and the number of downloads found on this study indicates that as the number of

downloads increases, there is a tendency for user ratings to increase as well. This relationship may be due to consumers relying on ratings when deciding to download an app (Sällberg et al., 2022) as higher ratings can attract new users, leading to increased downloads.

#### **4.3 Strengths, Limitations, and Recommendations**

This study aimed to provide a comprehensive understanding of the quality of free apps that can assist parents in managing stress and several strengths are worth highlighting. The researcher did not find another study that has extensively investigated these types of apps. The methodology employed a comprehensive and well-documented search strategy, including keyword searches on the Google Play Store and literature searches on Scopus and PubMed databases. This approach aimed to include a diverse range of apps and increase the robustness of the analysis. The study employed a rigorous evaluation of the apps by combining different evaluation methods using the well-established and validated MARS tool and the Persuasive System Design framework. The analysis of PSD elements was complemented by examining the correlation between the number of persuasive design elements and app popularity among users, providing insights into real-world reception and user satisfaction.

This study has also some limitations that should be acknowledged. One limitation concerns the limited number of apps available for screening. Due to the Play Store's search algorithm, only a restricted number of results ( $n=30$ ) were displayed based on their relevance criteria. Many apps found were duplicates (199 out of 420), and potentially other apps for parents did not appear in the results. Despite of finding 420 apps only a small proportion met the inclusion criteria and were included in the analysis. This limited sample size reduces the generalizability of the findings and may not fully represent the available apps in the market. Future research could address this limitation by finding alternatives to expand the sample size to include a larger number of apps. This could be achieved by trying other methods to expand

the results presented by the Play Store not found by this author or adding search in other apps stores such as Apple Store. Another limitation of the study is the lack of a second independent researcher to evaluate the apps using the MARS, which prevented the establishment of inter-rater reliability. The evaluation conducted by a single researcher introduces the possibility of subjective bias and limits the reliability of the ratings. Involving a second independent researcher would have increased the rigor and credibility of the app quality assessment, however that was not possible because the author could not find other person with the knowledge and amount of time available to perform the task. Finally, while the study evaluates the quality of the apps based on various dimensions, it does not assess the actual efficacy or effectiveness of the apps in reducing parental stress, not providing empirical evidence of the apps' impact on parental stress levels or well-being.

To advance research in this area, several recommendations can be made for future studies. Firstly, future studies should consider expanding the sample size to include a larger number of apps, providing more diverse and comprehensive data about the apps, enhancing the study's generalizability. Secondly, to address potential subjectivity and bias in the MARS scoring process and to enhance the reliability of the findings, involving multiple evaluators is recommended. Finally, incorporating other methods to assess app quality, such as gathering user feedback from the Play Store or conducting user studies, could be beneficial. Including users' perspectives, experiences, and suggestions would provide valuable insights into the strengths and weaknesses of the apps from an end-user's point of view and would enrich the increase study's relevance to real-world usage scenarios. By implementing these recommendations in future studies, researchers can contribute to a more comprehensive and robust understanding of stress management apps for parents, benefiting those seeking effective tools to manage stress and improve their well-being.

#### 4.4 Overall conclusion

Overall, the findings of this study shed light on the quality and the use of persuasive elements on free apps available in the Google Play Store that aim to support parents dealing with stress. The evaluation using the MARS tool revealed that the parenting apps generally exhibited good quality across multiple dimensions. However, there were areas for improvement, particularly in terms of engagement and information quality. Besides, a diverse implementation of PSD elements was found within the apps analysed, being Primary Task Support and System Credibility Support the most popular categories present.

The practical implications of these findings are significant. Focusing on the parents' perspective, they should have access to different tools in order to develop positive ways to manage stress, and they should be able to rely in apps as an option to do so. Besides, they should be able to make informed decisions when choosing parenting apps to support their mental well-being. Findings like the ones highlighted in this study should be available so parents can select apps that align with their specific needs and preferences.

Besides, app developers can leverage the insights gained from this study to enhance the design and features of parenting apps. Addressing the low engagement scores by incorporating elements that promote user engagement, such as interactive content and customization options, can improve the overall user experience. By having more apps that excel in these areas available, parents can enhance their overall user experience, increase their motivation to use the app consistently, and potentially obtain greater benefits from the stress management resources provided. Moreover, concerning regarding specific parent's needs, no app included in this study had specific features considering parents of children with disabilities or chronic illnesses. As these factors contribute to heightened parental stress, this is something that should be focus of apps developers.

Furthermore, the findings highlight the need to critically assess the information quality provided by parenting apps. While the evaluated apps generally offered positive information quality, there is a clear lack of specificity regarding theoretical background and of evidence base for their effectiveness. That suggests the need to exist ways ensure that the information provided on these types of apps is evidence-based and grounded in well-established theoretical frameworks or at least to be more explicit for the final user when that is not the case of the app they are choosing to download. Besides, as seen in the number of articles found, there are scientific studies being developed about the apps, however the apps included on these studies are not available for population in general and this gap between the academia and the real-world should be diminished so the population in general could benefit from the studies developed inside the research centres.

In conclusion, the evaluated free apps in the Google Play Store aimed at supporting parents dealing with stress exhibit good overall quality. By addressing the identified areas for improvement, such as engagement, information quality and evidence base, these apps can offer even better user's experience and increase the potential benefits for parents dealing with stress. Also, app's theoretical background should be more explicit to the final user, and apps should actually base their features and content on the frameworks, not just mentioning them. Furthermore, apps that aim to help to reduce stress should be based on scientific evidence, meaning that scientific studies to establish its efficacy should be conducted. Ultimately, these efforts can contribute to the availability of high-quality, effective, and user-friendly apps that support parents in managing stress and promoting their mental well-being.

## References

- Austin, J., Drossaert, C. H. C., van Dijk, J., Sanderman, R., Børøsund, E., Mirkovic, J., Schotanus-Dijkstra, M., Peeters, N. J., Van 't Klooster, J.-W. J. R., Schroevers, M. J., & Bohlmeijer, E. T. (2022). Integrating Top-down and Bottom-up Requirements in eHealth Development: The Case of a Mobile Self-compassion Intervention for People With Newly Diagnosed Cancer. *JMIR Cancer*, 8(3), e37502. <https://doi.org/10.2196/37502>
- Apolinário-Hagen, J., Hennemann, S., Fritsche, L., Drüge, M., & Breil, B. (2019). Determinant Factors of Public Acceptance of Stress Management Apps: Survey Study. *JMIR Mental Health*, 6(11), e15373. <https://doi.org/10.2196/15373>
- Baker, B. L., McIntyre, L. L., Blacher, J., Crnic, K., Edelbrock, C., & Low, C. (2003). Pre-school children with and without developmental delay: behaviour problems and parenting stress over time. *Journal of Intellectual Disability Research*, 47(4-5), 217–230. <https://doi.org/10.1046/j.1365-2788.2003.00484.x>
- Burgdorf, V., Szabó, M., & Abbott, M. J. (2019). The Effect of Mindfulness Interventions for Parents on Parenting Stress and Youth Psychological Outcomes: A Systematic Review and Meta-Analysis. *Frontiers in Psychology*, 10. <https://doi.org/10.3389/fpsyg.2019.01336>
- Cachia, R. L., Anderson, A., & Moore, D. W. (2016). Mindfulness, Stress and Well-Being in Parents of Children with Autism Spectrum Disorder: A Systematic Review [Article]. *Journal of Child and Family Studies*, 25(1), 1-14. <https://doi.org/10.1007/s10826-015-0193-8>
- Cappa, K. A., Begle, A. M., Conger, J. C., Dumas, J. E., & Conger, A. J. (2011). Bidirectional Relationships Between Parenting Stress and Child Coping Competence: Findings

- From the Pace Study. *Journal of child and family studies*, 20(3), 334–342.  
<https://doi.org/10.1007/s10826-010-9397-0>
- Carrouel, F., du Sartz de Vigneulles, B., Bourgeois, D., Kabuth, B., Baltenneck, N., Nusbaum, F., Burge, V., Roy, S., Buchheit, S., Carrion-Martinaud, M.-L., Massoubre, C., Fraticelli, L., & Dussart, C. (2022). Mental Health Mobile Apps in the French App Store: Assessment Study of Functionality and Quality. *JMIR MHealth and UHealth*, 10(10), e41282. <https://doi.org/10.2196/41282>
- Chaouali, W., Ben Yahia, I., Lunardo, R., & Triki, A. (2019). Reconsidering the “what is beautiful is good” effect. *International Journal of Bank Marketing*, 37(7), 1525–1546.  
<https://doi.org/10.1108/ijbm-12-2018-0337>
- Coulon, S. M., Monroe, C. M., & West, D. S. (2016). A Systematic, Multi-domain Review of Mobile Smartphone Apps for Evidence-Based Stress Management. *American Journal of Preventive Medicine*, 51(1), 95–105. <https://doi.org/10.1016/j.amepre.2016.01.026>
- Cousino, M. K., & Hazen, R. A. (2013). Parenting Stress Among Caregivers of Children With Chronic Illness: A Systematic Review. *Journal of Pediatric Psychology*, 38(8), 809–828. <https://doi.org/10.1093/jpepsy/jst049>
- Crnic, K., & Ross, E. (2017). Parenting Stress and Parental Efficacy. *Parental Stress and Early Child Development*, 263–284. [https://doi.org/10.1007/978-3-319-55376-4\\_11](https://doi.org/10.1007/978-3-319-55376-4_11)
- Deater-Deckard K. (1998). Parenting stress and child adjustment: Some old hypotheses and new questions. *Clinical Psychology: Science and Practice*. 5:314–332.
- Deater-Deckard, K. (2004). *Parenting Stress*. New Haven, CT: Yale University Press.  
<https://doi.org/10.12987/yale/9780300103939.001.0001>
- Domhardt, M., Messner, E.-M., Eder, A.-S., Engler, S., Sander, L. B., Baumeister, H., & Terhorst, Y. (2021). Mobile-based interventions for common mental disorders in



- youth: a systematic evaluation of pediatric health apps. *Child and Adolescent Psychiatry and Mental Health*, 15(1). <https://doi.org/10.1186/s13034-021-00401-6>
- Dong, S., Dong, Q., Chen, H., & Yang, S. (2022). Mother's Parenting Stress and Marital Satisfaction During the Parenting Period: Examining the Role of Depression, Solitude, and Time Alone. *Frontiers in Psychology*, 13. <https://doi.org/10.3389/fpsyg.2022.847419>
- Donker, T., Petrie, K., Proudfoot, J., Clarke, J., Birch, M. R., & Christensen, H. (2013). Smartphones for smarter delivery of mental health programs: a systematic review. *Journal of medical Internet research*, 15(11), e2791. <https://doi.org/10.2196/jmir.2791>
- Döpfner, M., Wähne, L., Klemp, M.-T., Mühlenmeister, J., Schürmann, S., Hellmich, M., & Plück, J. (2020). Efficacy of web-assisted self-help for parents of children with ADHD (WASH) – a three-arm randomized trial under field/routine care conditions in Germany. *BMC Psychiatry*, 20(1). <https://doi.org/10.1186/s12888-020-2481-0>
- Fairfax, A., Brehaut, J., Colman, I., Sikora, L., Kazakova, A., Chakraborty, P., & Potter, B. K. (2019). A systematic review of the association between coping strategies and quality of life among caregivers of children with chronic illness and/or disability. *BMC Pediatr*, 19(1), 215. <https://doi.org/10.1186/s12887-019-1587-3>
- Fang, Y., Boelens, M., Windhorst, D. A., Raat, H., & Grieken, A. (2021). Factors associated with parenting self-efficacy: A systematic review. *Journal of Advanced Nursing*. <https://doi.org/10.1111/jan.14767>
- Fang, Y., Luo, J., Boele, M., Windhorst, D., van Grieken, A., & Raat, H. (2022). Parent, child, and situational factors associated with parenting stress: a systematic review. *European Child & Adolescent Psychiatry*. [doi.org/10.1007/s00787-022-02027-1](https://doi.org/10.1007/s00787-022-02027-1)

- Fram, M.S. (2003). *Managing to Parent: Social Support, Social Capital, and Parenting Practices among Welfare-Participating Mothers with Young Children*. University of Washington, Washington, DC.
- Gan, D. Z. Q., McGillivray, L., Han, J., Christensen, H., & Torok, M. (2021). Effect of Engagement With Digital Interventions on Mental Health Outcomes: A Systematic Review and Meta-Analysis. *Frontiers in Digital Health*, 3.  
<https://doi.org/10.3389/fdgth.2021.764079>
- Gosetto, L., titia, Ehrler, F., dé, ric, & Falquet, G. (2020). Personalization Dimensions for MHealth to Improve Behavior Change: A Scoping Review. *Ebooks.iospress.nl*; IOS Press. <https://ebooks.iospress.nl/volumearticle/56056>
- Greenberg, J. S. (2021). *Comprehensive stress management*. McGraw-Hill Education.
- Hidi, S. (2015). Revisiting the Role of Rewards in Motivation and Learning: Implications of Neuroscientific Research. *Educational Psychology Review*, 28(1), 61–93.  
<https://doi.org/10.1007/s10648-015-9307-5>
- Jeong, J., Franchett, E. E., Ramos de Oliveira, C. V., Rehmani, K., & Yousafzai, A. K. (2021). Parenting interventions to promote early child development in the first three years of life: A global systematic review and meta-analysis. *PLOS Medicine*, 18(5), e1003602. <https://doi.org/10.1371/journal.pmed.1003602>
- Kaveladze, B. T., Wasil, A. R., Bunyi, J. B., Ramirez, V., & Schueller, S. M. (2022). User Experience, Engagement, and Popularity in Mental Health Apps: Secondary Analysis of App Analytics and Expert App Reviews. *JMIR Human Factors*, 9(1), e30766.  
<https://doi.org/10.2196/30766>
- Lau, N., O'Daffer, A., Yi-Frazier, J. P., & Rosenberg, A. R. (2021). Popular Evidence-Based Commercial Mental Health Apps: Analysis of Engagement, Functionality, Aesthetics,

- and Information Quality. *JMIR MHealth and UHealth*, 9(7), e29689.  
<https://doi.org/10.2196/29689>
- Lazarus, R. S., & Folkman, S. (1984). *Stress, appraisal, and coping*. New York: Springer Publishing Company.
- Li, Y.-M., & Yeh, Y.-S. (2010). Increasing trust in mobile commerce through design aesthetics. *Computers in Human Behavior*, 26(4), 673–684.  
<https://doi.org/10.1016/j.chb.2010.01.004>
- Marzano, L., Bardill, A., Fields, B., Herd, K., Veale, D., Grey, N., & Moran, P. (2015). The application of mHealth to mental health: opportunities and challenges. *The Lancet Psychiatry*, 2(10), 942–948. [https://doi.org/10.1016/s2215-0366\(15\)00268-0](https://doi.org/10.1016/s2215-0366(15)00268-0)
- Matthews, J., Win, K. T., Oinas-Kukkonen, H., & Freeman, M. (2016). Persuasive Technology in Mobile Applications Promoting Physical Activity: a Systematic Review. *Journal of Medical Systems*, 40(3). <https://doi.org/10.1007/s10916-015-0425-x>
- Meadan, H., Halle, J. W., & Ebata, A. T. (2010). Families with children who have autism spectrum disorders: Stress and support [Article]. *Exceptional Children*, 77(1), 7-36.  
<https://doi.org/10.1177/001440291007700101>
- Melcher, J., Camacho, E., Lagan, S., & Torous, J. (2020). College student engagement with mental health apps: analysis of barriers to sustained use. *Journal of American College Health*, 1–7. <https://doi.org/10.1080/07448481.2020.1825225>
- Ngai, F. W., Wong, P. W.-C., Chung, K. F., & Leung, K. Y. (2016). The effect of telephone-based cognitive-behavioural therapy on parenting stress: A randomised controlled trial. *Journal of Psychosomatic Research*, 86, 34–38.  
<https://doi.org/10.1016/j.jpsychores.2016.03.016>

- Ng, C. S. M., Fang, Y., Wang, Z., & Zhang, M. (2021). Potential Factors of Parenting Stress in Chinese Parents of Children With Autism Spectrum Disorder: A Systematic Review. *Focus on Autism and Other Developmental Disabilities*, 36(4), 237-248. <https://doi.org/10.1177/10883576211012599>
- Oinas-Kukkonen, H., & Harjuma, M. (2009). Persuasive systems design: Key issues, process model, and system features. *Communications of the Association for Information Systems*, 24(1), 28. <http://dx.doi.org/10.17705/1CAIS.02428>
- Onyishi, C. N., Sefotho, M. M., & Victor-Aibodion, V. (2023). Psychological distress among parents of children with autism spectrum disorders: A randomized control trial of cognitive behavioural therapy. *Research in Autism Spectrum Disorders*, 100, 102070. <https://doi.org/10.1016/j.rasd.2022.102070>
- Păsărelu, C. R., Kertesz, R., & Anca Dobrea. (2023). The Development and Usability of a Mobile App for Parents of Children with ADHD. *Children (Basel)*, 10(1), 164–164. <https://doi.org/10.3390/children10010164>
- Peer, J. W., & Hillman, S. B. (2014). Stress and Resilience for Parents of Children With Intellectual and Developmental Disabilities: A Review of Key Factors and Recommendations for Practitioners. *Journal of Policy and Practice in Intellectual Disabilities*, 11(2), 92–98. <https://doi.org/10.1111/jppi.12072>
- Pit, S. W., Tan, A. J. H., Ramsden, R., Payne, K., Freihaut, W., Hayes, O., Eames, B., Edwards, M., & Colbran, R. (2022). Persuasive Design Solutions for a Sustainable Workforce: Review of Persuasive Apps for Real-Time Capability Support for Rural Health Care Professionals. *JMIR MHealth and UHealth*, 10(2), e33413. <https://doi.org/10.2196/33413>
- Powell, T. J., & Enright, S. J. (2015). *Anxiety and stress management*. Routledge.

- Robinson, M., & Neece, C. L. (2015). Marital satisfaction, parental stress, and child behavior problems among parents of young children with developmental delays. *Journal of Mental Health Research in Intellectual Disabilities*, 8(1), 23–46.  
<https://doi.org/10.1080/19315864.2014.994247>
- Roth, S., & Cohen, L. J. (1986). Approach, avoidance, and coping with stress. *American Psychologist*, 41(7), 813–819. <https://doi.org/10.1037/0003-066X.41.7.813>
- Sakamoto, J. L., Carandang, R. R., Kharel, M., Shibamura, A., Yarotskaya, E., Basargina, M., & Jimba, M. (2022). Effects of mHealth on the psychosocial health of pregnant women and mothers: a systematic review. *BMJ Open*, 12(2), e056807.  
<https://doi.org/10.1136/bmjopen-2021-056807>
- Sällberg, H., Wang, S., & Numminen, E. (2022). The combinatory role of online ratings and reviews in mobile app downloads: an empirical investigation of gaming and productivity apps from their initial app store launch. *Journal of Marketing Analytics*.  
<https://doi.org/10.1057/s41270-022-00171-w>
- Schultchen, D., Terhorst, Y., Holderied, T., Stach, M., Messner, E.-M., Baumeister, H., & Sander, L. B. (2020). Stay Present with Your Phone: A Systematic Review and Standardized Rating of Mindfulness Apps in European App Stores. *International Journal of Behavioral Medicine*, 28(5), 552–560. <https://doi.org/10.1007/s12529-020-09944-y>
- Seo M., Choi B. Y., Jo H. I. (2006). The effect of life stress, stress coping, and social support on mental health. *Korea Journal of Counseling* 7(2):271–288.
- Sharma, S., Govindan, R., & Kommu, J. V. S. (2022). Effectiveness of Parent-to-Parent Support Group in Reduction of Anxiety and Stress Among Parents of Children With Autism and Attention Deficit Hyperactivity Disorder. *Indian Journal of Psychological Medicine*, 025371762110729. <https://doi.org/10.1177/02537176211072984>

- Shorey, S., & Ng, E. D. (2021). The efficacy of mindful parenting interventions: A systematic review and meta-analysis. *International Journal of Nursing Studies*, 103996. <https://doi.org/10.1016/j.ijnurstu.2021.103996>
- Shorey, S., Law, E., Mathews, J., Lim, S. H., Shi, L., Chua, J. S., Du, R., Chan, Y. H., Tan, T. C., Chee, C., & Chong, Y. S. (2023). Evaluating the Effectiveness of the Supportive Parenting App on Parental Outcomes: Randomized Controlled Trial. *Journal of Medical Internet Research*, 25, e41859. <https://doi.org/10.2196/41859>
- Shorey, S., Chong, Y. S., Shi, L., Chua, J. S., Thilagamangai, Mathews, J., Lim, S. H., Du, R., Chan, Y. H., Tan, T. C., Chee, C., & Law, E. (2023b). Evaluating the Effects of the Supportive Parenting App on Infant Developmental Outcomes: Longitudinal Study. *JMIR MHealth and UHealth*, 11(1), e43885. <https://doi.org/10.2196/43885>
- Sinha, R. (2001). How does stress increase risk of drug abuse and relapse? *Psychopharmacology*, 158(4), 343–359. <https://doi.org/10.1007/s002130100917>
- Sittig, S., McGowan, A., & Iyengar, S. (2020). Extensive Review of Persuasive System Design Categories and Principles: Behavioral Obesity Interventions. *Journal of Medical Systems*, 44(7). <https://doi.org/10.1007/s10916-020-01591-w>
- Statista. (2023a). *Mobile internet usage worldwide - Statistics & Facts*. <https://www.statista.com/topics/779/mobile-internet/#topicOverview> [accessed on 10/04/2023]
- Statista. (2023b). *Number of mHealth apps available in the Google Play Store from 1st quarter 2015 to 3rd quarter 2022*. <https://shorturl.at/erwxz> [accessed on 13/06/2023]
- Statista. (2023c). *Mobile operating systems' market share worldwide from 1st quarter 2009 to 1st quarter 2023*. <https://www.statista.com/statistics/272698/global-market-share-held-by-mobile-operating-systems-since-2009/> [accessed on 10/04/2023]

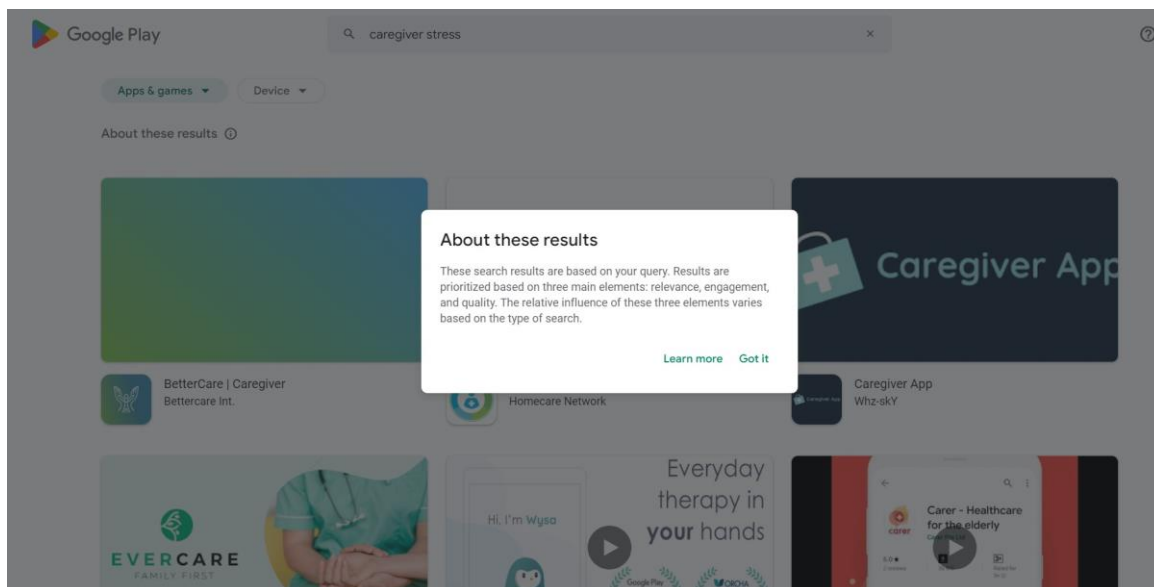
- Statista. (2023d). *Distribution of free and paid apps in the Apple App Store and Google Play as of March 2023*. <https://www.statista.com/statistics/263797/number-of-applications-for-mobile-phones/> [accessed on 10/04/2023]
- Stoyanov, S. R., Hides, L., Kavanagh, D. J., Zelenko, O., Tjondronegoro, D., & Mani, M. (2015). Mobile App Rating Scale: A New Tool for Assessing the Quality of Health Mobile Apps. *JMIR MHealth and UHealth*, 3(1), e27. <https://doi.org/10.2196/mhealth.3422>
- Suh, B., & Luthar, S. S. (2020). Parental aggravation may tell more about a child's mental/behavioral health than Adverse Childhood Experiences: Using the 2016 National Survey of Children's Health. *Child Abuse & Neglect*, 101, 104330. <https://doi.org/10.1016/j.chiabu.2019.104330>
- Urbanowicz, A. M., Shankland, R., Rance, J., Bennett, P., Leys, C., & Gauchet, A. (2023). Cognitive behavioral stress management for parents: Prevention and reduction of parental burnout. *International Journal of Clinical and Health Psychology*, 23(4), 100365. <https://doi.org/10.1016/j.ijchp.2023.100365>
- van Velsen, L., Beaujean, D. J., & van Gemert-Pijnen, J. E. (2013). Why mobile health app overload drives us crazy, and how to restore the sanity. *BMC Medical Informatics and Decision Making*, 13(1). <https://doi.org/10.1186/1472-6947-13-23>
- Vertola, G., Marcello, A., Bottone, M., Sperandeo, R., Muzii, B., Scandurra, C., & Maldonato, N. M. (2022, September 1). Use and Effectiveness of Mobile Health Applications for Stress Management and Emotional Self-Regulation in Adult Workers: A Systematic Review. *IEEE Xplore*. <https://doi.org/10.1109/CogInfoCom55841.2022.10081617>

- Waters, L., & Sun, J. (2016). Can a Brief Strength-Based Parenting Intervention Boost Self-Efficacy and Positive Emotions in Parents? *International Journal of Applied Positive Psychology*, 1(1-3), 41–56. <https://doi.org/10.1007/s41042-017-0007-x>
- Webster-Stratton, C. (1990). Stress: A potential disruptor of parent perceptions and family interactions. *Journal of Clinical Child Psychology*, 19, 302–312.
- Weekly, T., Walker, N., Beck, J., Akers, S., & Weaver, M. (2018). A Review of Apps for Calming, Relaxation, and Mindfulness Interventions for Pediatric Palliative Care Patients. *Children*, 5(2), 16. <https://doi.org/10.3390/children5020016>
- Wintermeyer, Simon A. (2021) Positive psychology apps : a systematic review of the quality and characteristics of a selection of current free-of-charge positive psychological apps aiming to enhance resilience available in the Google Play Store. [Master's thesis, University of Twente]. <https://essay.utwente.nl/89052/>
- World Health Organization (2011) mHealth: New horizons for health through mobile technologies. <https://apps.who.int/iris/handle/10665/44607> [accessed on 10/04/2023]
- Wu, X., Xu, L., Li, P., Tang, T., & Huang, C. (2022). Multipurpose Mobile Apps for Mental Health in Chinese App Stores: Content Analysis and Quality Evaluation. *JMIR MHealth and UHealth*, 10(1), e34054. <https://doi.org/10.2196/34054>



## Appendix

### Appendix A: Play Store prioritization of search results



## Appendix B: Spreadsheet with search results scrapped

KEYWORD	#	NAME	URL	DEVELOPER	DESCRIPTION
Caregiver apps	1	CareLinX: In-Home Care	<a href="https://play.google.com/store/apps">https://play.google.com/store/apps</a>	CareLinX	CareLinX connects families with safe, reliable, and affordable in-home caregivers for seniors. With the help of our CareLinX Caregivers, you can work with Purpose and Reward.
	2	Evercare Caregiver	<a href="https://play.google.com/store/apps">https://play.google.com/store/apps</a>	Evercare Health	Work with Purpose and Reward.
	3	Carer - Healthcare for the elderly	<a href="https://play.google.com/store/apps">https://play.google.com/store/apps</a>	Carer Pte Ltd	Carer is a mobile app that enables people to take care of themselves and others conveniently. Patients with chronic conditions can use the app to manage their health and receive reminders for medication and appointments.
	4	Homecare for Caregiver	<a href="https://play.google.com/store/apps">https://play.google.com/store/apps</a>	Homecare Network	Homecare platform is designed to assist Homecare industry to cope with the increasing number of clients. The application is part of a comprehensive management system for managing care for elders. In order to provide the best care, the application is designed to assist Homecare industry to cope with the increasing number of clients.
	5	BetterCare   Caregiver	<a href="https://play.google.com/store/apps">https://play.google.com/store/apps</a>	Bettercare Int.	The application is part of a comprehensive management system for managing care for elders. In order to provide the best care, the application is designed to assist Homecare industry to cope with the increasing number of clients.
	6	CareGiver	<a href="https://play.google.com/store/apps">https://play.google.com/store/apps</a>	My CareShare	My CareShare is an innovative way for experienced and qualified Caregivers to have the freedom to set their own schedule and work from home. The application is part of a comprehensive management system for managing care for elders. In order to provide the best care, the application is designed to assist Homecare industry to cope with the increasing number of clients.
	7	Caregiver App	<a href="https://play.google.com/store/apps">https://play.google.com/store/apps</a>	Whiz-sky	Comprehensive guide to providing caregiving and nursing to patients in their homes.
	8	Caregiver Jobs In USA	<a href="https://play.google.com/store/apps">https://play.google.com/store/apps</a>	Cash Money Apps	A caregiver is one who takes care of the elderly, kids and the sick. It is a very prestigious job which highly individual wellness monitoring is poised to enhance the health care industry. We provide the facility to register and manage the caregiver's schedule and availability.
	9	Caregiver App	<a href="https://play.google.com/store/apps">https://play.google.com/store/apps</a>	CallTek, Inc.	A caregiver is one who takes care of the elderly, kids and the sick. It is a very prestigious job which highly individual wellness monitoring is poised to enhance the health care industry. We provide the facility to register and manage the caregiver's schedule and availability.
	10	Caregiver Saathi	<a href="https://play.google.com/store/apps">https://play.google.com/store/apps</a>	Brained.app	Caregiver Saathi is an ecosystem that enables compassionate caring. We provide family caregivers with a comprehensive guide to providing caregiving and nursing to patients in their homes.
	11	Caregiver Jobs In USA	<a href="https://play.google.com/store/apps">https://play.google.com/store/apps</a>	Cash Money Apps	A caregiver is one who takes care of the elderly, kids and the sick. It is a very prestigious job which highly individual wellness monitoring is poised to enhance the health care industry. We provide the facility to register and manage the caregiver's schedule and availability.
	12	Elderly Care: health + protect	<a href="https://play.google.com/store/apps">https://play.google.com/store/apps</a>	LEVStone	This senior app improves a loved one's physical and mental health and well-being by helping them: 1. Track their health and wellness 2. Receive reminders for medication and appointments 3. Connect with family and friends 4. Access emergency services
	13	ES Caregiver	<a href="https://play.google.com/store/apps">https://play.google.com/store/apps</a>	Elders and Seniors	Need elder care services at your home? This app is a must-have and comes handy to order our services. Our Caregivers application is designed for Doctors & Caregiver staff in order to constantly keep them in the loop.
	14	CHI Caregiver	<a href="https://play.google.com/store/apps">https://play.google.com/store/apps</a>	Cognitive Healthcare Intl.	Description: During a health journey, everyone wants to know what's going on, and how they can help. Public social media is a great resource for finding support and information, but it can be overwhelming and time-consuming. Empowering caregivers to grow and to improve their clients' quality of life.
	15	Caregiver	<a href="https://play.google.com/store/apps">https://play.google.com/store/apps</a>	Madhavbaug Clinic	Introducing "Caregiving Together," a user-friendly app designed to help people care for their elders or patients. The app allows caregivers to easily and quickly allow the syncing of information between caregiver and patient and vice versa for the caregivers.
	16	CaringBridge	<a href="https://play.google.com/store/apps">https://play.google.com/store/apps</a>	CaringBridge.org	Lifeâ€™s more manageable when you have the right tools. The Peace of Mind system is two Android apps: Patient and Caregiver. Caregivers - start here! Download the app and you'll be able to connect with your loved ones and receive reminders for medication and appointments.
	17	Empathy Caregiver - Caregiver	<a href="https://play.google.com/store/apps">https://play.google.com/store/apps</a>	Empathy Algorithm LLC	Empowering caregivers to grow and to improve their clients' quality of life.
	18	Caregiving Together	<a href="https://play.google.com/store/apps">https://play.google.com/store/apps</a>	Fitric	Introducing "Caregiving Together," a user-friendly app designed to help people care for their elders or patients. The app allows caregivers to easily and quickly allow the syncing of information between caregiver and patient and vice versa for the caregivers.
	19	CareGiver Assistant - CGA	<a href="https://play.google.com/store/apps">https://play.google.com/store/apps</a>	Web Coast Apps - Apps For Life	CGA can easily and quickly allow the syncing of information between caregiver and patient and vice versa for the caregivers.
	20	C4CD Caregiver	<a href="https://play.google.com/store/apps">https://play.google.com/store/apps</a>	Save the Children in Bangladesh	Lifeâ€™s more manageable when you have the right tools. The Peace of Mind system is two Android apps: Patient and Caregiver. Caregivers - start here! Download the app and you'll be able to connect with your loved ones and receive reminders for medication and appointments.
	21	Caring - making caregiving manageable	<a href="https://play.google.com/store/apps">https://play.google.com/store/apps</a>	Intelligent Maintenance LLC	Lifeâ€™s more manageable when you have the right tools. The Peace of Mind system is two Android apps: Patient and Caregiver. Caregivers - start here! Download the app and you'll be able to connect with your loved ones and receive reminders for medication and appointments.
	22	Peace of Mind: Caregiver	<a href="https://play.google.com/store/apps">https://play.google.com/store/apps</a>	peaceofmind.ai	The Peace of Mind system is two Android apps: Patient and Caregiver. Caregivers - start here! Download the app and you'll be able to connect with your loved ones and receive reminders for medication and appointments.
	23	MyShyft: Caregivers On Demand	<a href="https://play.google.com/store/apps">https://play.google.com/store/apps</a>	RestUp, LLC dba MyShyft	MyShyft is an app that connects health care facilities to health care workers without the middle man of a dispatcher. MyShyft is an app that connects health care facilities to health care workers without the middle man of a dispatcher.
	24	Alzheimer's Daily Companion	<a href="https://play.google.com/store/apps">https://play.google.com/store/apps</a>	Home Instead Senior Care	Alzheimer's Daily Companion is an app that helps caregivers manage the daily care of their loved ones with Alzheimer's disease. Alzheimer's Daily Companion is an app that helps caregivers manage the daily care of their loved ones with Alzheimer's disease.
	25	Claris for Caregivers	<a href="https://play.google.com/store/apps">https://play.google.com/store/apps</a>	Claris Healthcare	***This app is for friends, family and caregivers already connected with a Claris Companion member. To support family caregivers play a central role in the care of persons with severe mental illness. This is an important role that family caregivers play a central role in the care of persons with severe mental illness.
	26	Family Caregiver Support	<a href="https://play.google.com/store/apps">https://play.google.com/store/apps</a>	Center of Social Innovation	Family caregivers play a central role in the care of persons with severe mental illness. This is an important role that family caregivers play a central role in the care of persons with severe mental illness.
	27	Caregiver Online Shop	<a href="https://play.google.com/store/apps">https://play.google.com/store/apps</a>	Appmasterbd	Caregiver is a platform here people can purchase all kinds of goods. From a pencil to a book to a natural gas stove. Caregiver is your one-stop solution for a full and holistic range of healthcare services provided by fully licensed professionals.
	28	Homage - Care Where You Are	<a href="https://play.google.com/store/apps">https://play.google.com/store/apps</a>	Homage Co Pte Ltd	Homage is your one-stop solution for a full and holistic range of healthcare services provided by fully licensed professionals.
	29	Home Care Services for Elders	<a href="https://play.google.com/store/apps">https://play.google.com/store/apps</a>	Elders and Seniors	Our services are currently available in Chennai city only.

## Appendix C: MARS and PSD evaluation criteria

### 1. Criteria for the MARS Scores

#### ENGAGEMENT

##### Fun

Is the app fun or entertaining? Does it use any strategies to increase engagement through entertainment (eg gamification)?

- 1 Dull, not fun or entertaining at all
- 2 Mostly boring
- 3 Okay, fun enough to entertain for a brief time (<5MIN)
- 4 Moderately fun and entertaining would entertain for some time (5-10 min total)
- 5 Highly entertaining and fun, would stimulate repeat use

##### Interest

Is the app interesting to use? Does it use any strategies to increase engagement by presenting its content in an interesting way?

- 1 Not interesting at all
- 2 Mostly uninteresting
- 3 okay, neither interesting nor interesting; would engage user for a brief time (<5min)
- 4 moderately interesting; would engage user for some time (5-10 min total)
- 5 Very interesting, would engage user in repeat use

##### Customization

Allows tailoring of settings according to individual characteristics or preferences for features sound, content...)

- 1 Does not allow customisations or requires setting to be input every time
- 2 Allows insufficient customisation in limiting functions
- 3 Allows basic customisation
- 4 Allows numerous options for customisation
- 5 Allows complete tailoring to the individual's characteristic/preferences, retains all settings

##### Interactivity

- 1 No interactive features and/or no response to user interaction
- 2 Insufficient interactivity or feedback or user input options, limiting functions
- 3 Basic interactive features
- 4 Offers a variety of interactive features/feedback/user input options
- 5 Very high level of responsiveness through interactive features/feedback/user input options

##### Target Group

- 1 Completely inappropriate/unclear/confusing
- 2 Mostly inappropriate/unclear/confusing
- 3 Acceptable but not targeted. May be inappropriate/unclear/confusing
- 4 Well-target, with negligible issues
- 5 Perfectly target, no issues found

## FUNCTIONALITY

### Performance

How accurately and fast do the app features functions and components (buttons/menus) work?

- 1 Apps is broken, no/insufficient inaccurate response
- 2 Apps works overall. Some technical problems need fixing/slow at times
- 3 Apps works overall. Some technical problems need fixing/slow at times
- 4 Mostly functional with minor /negligible problems
- 5 Perfect/timely response; no technical bugs

### Easy of use

How easy is to learn to use the app? How clear are the menu labels, icons and instructions?

- 1 No/limited instructions; menu labels/icons are confusing, complicated
- 2 Useable after a lot of time/ effort
- 3 Useable after a some time /effort
- 4 Easy to learn how to use the app or has clear instructions)
- 5 Able to use the app immediately; intuitive and simple

### Navigation

Is moving between screens logical, accurate, uninterrupted? Are all necessary screen links present?

- 1 Different sections within the app seem logically disconnected and random/confusing/navigation is difficult
- 2 Useable after a lot of time/ effort
- 3 Useable after a some time /effort
- 4 Easy to use or missing a negligible link
- 5 Perfectly logical, easy, clear intuitive screen flow throughout or offer shortcuts

### Gestural Design

Are interactions (taps, swipes, pinche, scrolls) consistent and intuitive across all components?

- 1 Completely inconsistent/confusing
- 2 Often inconsistent/confusing
- 3 Okay with some inconsistencies/confusing elements
- 4 Mostly consistent and intuitive
- 5 Perfectly consistent and intuitive

## AESTHETICS

### Layout

Is arrangement and size of buttons, icons, menus, content on the screen appropriate or zoomable if needed?

- 1 Very bad design, cluttered, some options impossible to select/locate/see/read device display not optimised
- 2 Bad design, random, unclear, some options difficult to select/locate/see/read
- 3 Satisfactory, few problems with selecting/locating/seeing/reading items or with minor screen size problems

- 4 Mostly clear, able to select/locate/see/read/items
- 5 Professional, simple, clear, orderly, logically organised, device display optimised. Every design component has a purpose.

#### Graphics

How high is the quality/resolution of graphics used for buttons icons/menus/content?

- 1 Graphics appear amateur, very poor visual design
- 2 Low quality/low resolution graphics, low quality visual design
- 3 Moderate quality graphics and visual design (generally consistent in style)
- 4 High quality/resolution graphics and visual design
- 5 Very High quality/resolution graphics and visual design

#### Visual appeal

How good does the app look?

- 1 No visual appeal, unpleasant to look at, poorly designed, clashing/mismatching colors
- 2 Little visual appeal – poorly designed, bad use of color, visually boring
- 3 Some visual appeal – average, neither pleasant nor unpleasant
- 4 High level of visual appeal – seamless graphics – consistent and professionally designed
- 5 As number 4 and very attractive, memorable, stands out: use of color enhances the app features/menu

#### **INFORMATION**

accuracy of app description

- 1 Misleading. App does not contain the described components/functions. Or has no description.
- 2 Inaccurate. App contains very few of the described components/functions.
- 3 Okay. App contains some of the described components/functions
- 4 Accurate. App contains most of the of the described components/functions
- 5 Highly accurate description of the described components/functions

#### Goals

App has specific, measurable and achievable goals (specified in the store description or within the app)

N/A Description does not lists goals or app goals are irrelevant to research goal

- 1 App has no chance of achieving its stated goals
- 2 Description lists some goals but app has very little chance of achieving them
- 3 Okay. App has clear goals, which may be achievable.
- 4 App has clearly specified goals, which are measurable and achievable.
- 5 App has specific and measurable goals which are highly likely to be achieved

#### Quality of information

Is the information relevant, competent, appropriate and not potentially harmful to the users?

N/A There is no information within the app

- 1 Irrelevant/inappropriate/incoherent/incorrect
- 2 Poor. Barely relevant appropriate/coherent/may be incorrect
- 3 Moderately relevant appropriate/coherent and appears correct
- 4 relevant appropriate/coherent/correct
- 5 Highly relevant appropriate/coherent/correct

#### Quantity of information

Is the extent of coverage within the scope of the app, and comprehensive but concise?

N/A There is no information within the app

- 1 Minimal or overwhelming
- 2 Insufficient or possibly overwhelming
- 3 Okay but not comprehensive or concise
- 4 Offers a broad range of information, has some gaps or unnecessary detail; or has no links to more information and resources
- 5 Comprehensive and concise; contains links to more information and resources

#### Visual information

Is visual explanation of concepts through charts, graphs, images, videos, etc) clear, logical and correct?

N/A There is no visual information within the app

- 1 Completely unclear/confusing/wrong or necessary but missing
- 2 Mostly unclear/confusing/wrong
- 3 Okay but often unclear/confusing/wrong
- 4 Mostly clear/logical/correct with negligible issues
- 5 Perfectly clear/logical/correct

#### Credibility

Does the app come from a legitimate source specified in app store description or within the app)?

- 1 Source identified but legitimacy/trustworthiness of source is questionable
- 2 Appears to come from a legitimate source, but it cannot be verified (eg has no webpage)
- 3 Developed by small NGO / institution /specialized commercial business/funding body
- 4 Developed by government, university or as number 3 but larger in scale
- 5 Developed using nationally competitive government or research funding

#### Evidence Based

Has the app been trialled/tested?

N/A App has not been trialled/tested

- 1 Evidence suggests the app does not work
- 2 app has been trialled and has partially positive outcomes in studies that are not RCTs  
Or there is little contradictory evidence
- 3 app has been trialled and has positive outcomes in studies that are not RCTs  
Or there is no contradictory evidence
- 4 app has been trialled and outcome tested in 1-2 RCTs indicating positive results
- 5 app has been trialled and outcome tested in 3 or more RCTs indicating positive results

## 2. Criteria for the Persuasive System Design elements

### Primary Task Support

Reduction	The user's effort in performance with features should be limited.
Tunnelling	System should provide some sort of guidance and means for action.
Tailoring	Information should be tailored to the targeted users.
Personalization	Content should be able to be personalized.
Self-Monitoring	Users should be able to track their current performances.
Simulation	System should provide observations of cause and effects concerning targeted topics.
Rehearsal	Users should find means to rehearse focused behaviours within the system.

### Dialogue Support

Praise	Users should receive feedback in terms of praising words, symbols, images or sounds.
Rewards	Users should be able to receive some sort of rewards for their performance.
Reminders	Users should be reminded by the system to perform the targeted behaviour.
Suggestions	Users should receive suggestions in performing targeted behaviours in real-life.
Similarity	Users should feel imitated in some way by the system.
Liking	The design and appearance of the system should be appealing.
Social Role	A social model or role should be adopted within the system.

### System Credibility

Trustworthiness	Truthful, unbiased, and fair information should be provided by the system.
Expertise	System should show knowledge and competence behind provided information.
Surface Credibility	System should feel and look competent.
Real-world-feel	Users should be able to find information about the founders and people/organizations behind the system.
Authority	Users should find references to people or organisations of authority.
Third-party endorsements	System should endorse respected external sources.
Verifiability	Accuracy of presented information should be verified by external sources.

**Social Support**

Social learning	Other users should somehow be observable in their performance of targeted behaviours within the system.  System should provide means to observe other users who are performing their target behaviors and to see the outcomes of their behavior
Social comparison	Comparison with other users should be enabled.
Normative influence	System should gather people with same goals and topics to provide them a feeling of being normal.
Social facilitation	The possibility of discerning other users should be provided by the system.
Cooperation	Means for cooperation should be provided.
Competition	Means for competing with other users should be provided.
Recognition	Users should be able to recognize people who already perform targeted behaviours within the system.



## Appendix C: MARS and PSD detailed scoring

### 1. Scores engagement dimension

ENGAGEMENT											
#	APP	Justification	Interest	Justification	Customization	Justification	Interactivity	Justification	Target Group	Justification	Average
1	DadPad	Would entertain for the amount of time of reading the contents	3	Would engage for the amount of time of reading the contents	3	Only customization is the postcode and that will change the services available in the area	3	Only interactivity possible is provide feedback to the developers	5	Content is well-target	3.4
2	Expectful: Wellness for Moms	fun enough to entertain for a brief time with the features available for free	4	Moderately interesting; would engage user for some time	3	Allows basic customisation such as select moment of motherhood journey (trying, trimester expecting, mother...)	3	Offers basic interactive options in the free version	5	Content is well-target for moms, including different moments of motherhood journey	3.6
3	How To Be A Good Dad	Mostly boring as it is just plain text	3	Would engage user for a brief time	1	Does not allow customisations	1	No interactive features	4	Content is well-target for dads	2.2
4	Manatee: Family Mental Health	Features such as videos and animations of rewards make it entertaining for some time	4	Features such as videos and achieving goals make it engaging for some time	3	Allows basic customisation	4	It has a variety of ways to engage with the content, such setting goals, responding quiz, sharing on social media.	4	Content is well-target for families with further interest in therapy	3.6
5	Mental health for mom + Social	Interaction with other users make it entertaining for some time	4	Diverse features and social interactions possibilities make the app engaging for some time however a limited number is available for free	3	Allows basic customisation such as block posts with specific words	3	It has features to interact with other users (post, likes, chats). Part of the content is no longer available	4	Content is well-target for moms with interest in social connections	3.6
6	Mindful Mamas: Sleep for Moms	fun enough to entertain for a brief time with the features available for free	4	Diverse features make the app engaging for some time however a limited number is available for free	3	Allows basic customization	3	It offers basic interactive options in the free version	5	Content is well-target for moms	3.6
7	Parenting App Dadditude	entertaining and fun, would stimulate repeat use as it has many different features available however not all are free	4	Diverse features would engage user in repeat use as it has different features available, however not all are available for free	3	Allows basic customization. The notifications just can be chose according the options offered (user ca not choose specific time). User can add personal details and picture on profile	4	It has a variety of ways to engage with the content, such as saving bookmarks, interacting with other dads, sharing on social media, etc	5	Content is effectively target for dads	4
8	Parents	fun enough to entertain for a brief time with the features available for free	4	App provides some options of information for free	3	Allows basic customization (eg time of reminders, save bookmarks).	4	It has a variety of ways to engage with the content, such as sharing on social media or chatting with a bot	4	Content is well-target for parents with interested in scientific content	3.6
9	The Happy Child Parenting App	Provides a variety of content and features (articles, videos, lessons, and activities) that make it entertaining for some time.	4	App provides a range of information and activities in an interesting way (such as quizz after seeing part of the content), would engage for some time	3	Allows basic customization (eg time of reminders, save bookmarks).	4	It has a variety of ways to engage with the content, such as saving bookmarks, responding quiz, sharing on social media.	5	Content is well-target for parents with interested in scientific content with differentiation about the level of science knowledge and goals	4
AVERAGE			3.8		2.8		3.2		4.6		3.5

## 2. Scores functionality dimension

FUNCTIONALITY										
#	APP	Performance	Justification	Ease of use	Justification	Navigation	Justification	Gestural design	Justification	Average
1	DadPad	4	Mostly functional with minor /negligible problems	5	User is able to use the app immediately; app is intuitive and simple	5	Perfectly logical, easy, clear intuitive screen flow throughout.	4	App is mostly consistent and intuitive	4.5
2	Expectful: Wellness for Moms	5	Perfect response; no technical bugs	4	It is easy to learn how to use the app	4	App is easy to use	4	App is mostly consistent and intuitive	4.3
3	How To Be A Good Dad (Father)	4	Mostly functional with minor /negligible problems	5	User is able to use the app immediately; app is intuitive and simple	3	Useable after a some time as ads made the navigations slower	4	App is mostly consistent and intuitive	4.0
4	Manatee: Family Mental Health	4	Mostly functional with minor /negligible problems	4	It is easy to learn how to use the app	5	Perfectly logical, easy, clear intuitive screen flow throughout.	3	It is okay with a inconsistency as user needs to leave the app to read the full articles	4.0
5	Mental health for mom + Social	3	Videos are a feature not working.	4	It is easy to learn how to use the app	4	App is easy to use	3	App is okay with some inconsistencies as the icons for play the videos are still available however they don't play and	3.5
6	Mindful Mamas: Sleep for Moms	5	Perfect response; no technical bugs	4	It is easy to learn how to use the app	5	Perfectly logical, easy, clear intuitive screen flow throughout.	4	App is mostly consistent and intuitive	4.5
7	Parenting App Dadditude	5	Perfect response; no technical bugs	5	app is intuitive and simple	5	Perfectly logical, easy, clear intuitive screen flow throughout.	4	App is mostly consistent and intuitive	4.8
8	Parents	5	Perfect response; no technical bugs	4	It is easy to learn how to use the app	4	App is easy to use	4	App is mostly consistent and intuitive	4.3
9	The Happy Child Parenting App	4	Mostly functional with minor /negligible problems (reminders did not work until the following day)	5	app is intuitive and simple	4	App is easy to use	4	App is mostly consistent and intuitive	4.3
AVERAGE		4.3		4.4		4.3		3.8		4.2

## 3. Scores aesthetic dimension

AESTHETICS							
APP	layout	Justification	graphics	Justification	visual appeal	Justification	Average
DadPad	4	App is clear, user is able to select, locate and read items. Texts pages could have more pleasant presentation	4	Apps graphics and visual design have high quality and resolution	3	Some visual appeal – average. Texts pages and main page could have more pleasant presentation	3.7
Expectful: Wellness for Moms	5	App is professional, simple, clear, orderly and logically organised.	4	Apps graphics and visual design have high quality and resolution	3	Some visual appeal – average. App doesn't have any specific attractive features	4.0
How To Be A Good Dad (Father)	3	Satisfactory. Text could have a better desing to become more attractive	3	Moderate quality graphics and visual design (generally consistent in style)	2	Little visual appeal, visually boring	2.7
Manatee: Family Mental Health	4	App is clear, user is able to select, locate and read items	4	Apps graphics and visual design have high quality and resolution	5	App has high level of visual appeal.	4.3
Mental health for mom + Social	4	App is clear, user is able to select, locate and read items	4	Apps graphics and visual design have high quality and resolution	4	App has high level of visual appeal.	4.0
Mindful Mamas: Sleep for Moms	5	App is professional, simple, clear, orderly and logically organised.	4	Apps graphics and visual design have high quality and resolution	5	very memorable and the use of color	4.7
Parenting App Dadditude	5	App is professional, simple, clear, orderly and logically organised.	4	Apps graphics and visual design have high quality and resolution	4	App has high level of visual appeal.	4.3
Parents	4	App is clear, user is able to select, locate and read items	4	Apps graphics and visual design have high quality and resolution	3	Some visual appeal – average. Doesn't have any specific attractive features	3.7
The Happy Child Parenting App	5	App is professional, simple, clear, orderly and logically organised.	4	Apps graphics and visual design have high quality and resolution	4	App has high level of visual appeal.	4.3
AVERAGE		4.3		3.9		3.7	4.0

## 4. Scores information quality dimension

INFORMATION QUALITY															
APP	accuracy of app description	Justification	goals	Justification	Quality of inform.	Justification	Theoretical background	quantity of informat.	Justification	visual information	Justification	credibility	Justification	evidence base	Average
DadPad	4.0	App contains most of the of the described components functions however some are presented superficially	N/A		4.0	App offers relevant appropriate, coherent and correct information	Not specified	4.0	App offers a broad range of information, however for a limited area	N/A		5.0	App is developed using nationally government	N/A	4.3
Expectful: Wellness for Moms	5.0	App has highly accurate description of the described components and functions	4.0	App has clearly specified goals, which are measurable and achievable	4.0	App offers relevant appropriate, coherent and correct information	Mainly mindfulness	4.0	App offers a broad range of information, however very limited is free. It has no links to more information	5.0	Perfectly clear and logical, no issues found	3.0	Developed by specialized commercial business	N/A	4.0
How To Be A Good Dad (Father)	2.0	App contains very few of the described components/functions (eg "share your experience as a dad")	N/A		3.0	Moderately relevant appropriate information and appears correct	Not specified	3.0	Information okay but not concise or not properly organised	N/A		2.0	Appears to come from a legitimate source, but it cannot be verified (it has no webpage)	N/A	2.5
Manatee: Family Mental Health	5.0	App has highly accurate description of the described components and functions	4.0	App has clearly specified goals, which are measurable and achievable	4.0	App offers relevant appropriate, coherent and correct information	Not specified	4.0	App offers a broad range of information, has no links to more information	5.0	Visual information is perfectly clear, logical and correct	3.0	Developed by small institution	N/A	4.2
Mental health for mom + Social	4.0	App contains most of the of the described components functions	N/A		4.0	App offers relevant appropriate, coherent and correct information	Not specified	3.0	App offers a broad range of information, however part of it (videos) are not available and last update on articles was in more than a year	3.0	Visual information is okay, except for the video section	3.0	Developed by small NGO / institution	N/A	3.4
Mindful Mamas: Sleep for Moms	5.0	App has highly accurate description of the described components and functions	4.0	App has clearly specified goals, which are measurable and achievable	5.0	Highly relevant appropriate and correct information, based on scientific research	Mindfulness	4.0	App offers a broad range of information, however limited for free. It has no links to more information	5.0	Perfectly clear and logical, no issues found	3.0	Developed by specialized commercial business		4.2
Parenting App Dadditude	5.0	App has highly accurate description of the described components and functions	3.0	App has clear goals, which may be achievable.	5.0	Highly relevant appropriate and correct information, based on scientific research	Not specified	4.0	App offers a broad range of information, however limited for free.	5.0	Perfectly clear and logical	3.0	Developed by specialized commercial business	N/A	4.2
Parents	3.0	App description is more generalistic, the app has more detailed features	3.0	App has clear goals, which may be achievable.	4.0	App offers relevant appropriate, coherent and correct information	Not specified	3.0	Offers a limited amount of information on the free version.	5.0	Perfectly clear and logical, no issues found	3.0	Developed by specialized commercial business	N/A	3.5
The Happy Child Parenting App	4.0	App contains all of the of the described components functions. However some functions are not described on the app.	3.0	App has clear goals, which may be achievable. There are not how to measure they using the app though.	5.0	Highly relevant appropriate and correct information, based on scientific research	Not specified	4.0	Offers a broad range of information but has no links to more information and resources	5.0	Perfectly clear and logical, no issues found	4.0	Developed by non profit organisation not small	N/A	4.2

## 5. Evaluation Primary Task Support elements – PSD

APP	Reduction	Tunneling	Tailoring	Personalization	Self-monitoring	Simulation	Rehearsal	Used elements Fully	Used elements Partially
DadPad	Yes Easy to use and to find the features	Yes App provides guidance and means for action	Partially Content is specific to dads	Partially The services suggested on the app are according	No	No	No	2	2
Expectful: Wellness for Moms	Yes Easy to use and to find the features available	Yes App provides guidance and means for action	Partially Content is specific to moms	Yes Content can be personalized for 3 stages of pregnancy, motherhood or loss. can	Yes User can track the sessions, minutes meditated and longest streak	Partially Website mentions benefits of mediation	Yes Users have different practices within the	5	2
How To Be A Good Dad (Father)	Yes Easy to use and to find the features available	Yes App provides guidance and means for action	Partially Content is specific to parents	No	No	No	No	2	1
Manatee: Family Mental Health	Yes Easy to use and to find the features available	Yes App provides guidance and setting goals	Partially Content is specific to parents, mainly from UK	Partially User can select which courses want to watch	Yes User can keep track of actions	Partially Website mentions benefits for families	Partially App suggests small goals for users based on the lessons they	3	4
Mental health for mom + Social	Yes Easy to use and to find the features available	Partially App gives some guidance through the videos and articles, but mainly relies on the posts of the users	Partially Content is specific to moms	Partially User can set some preferences such as not receive feed with some keywords or check	partially User can keep track of couple features of their social interactions(what	No	No	1	4
Mindful Mamas: Sleep for Moms	Yes Easy to use and to find the features available	Yes App gives guidance and means for action based on user's mindfulness	Partially Content is specific to moms interested on mindfulness	Yes User gets content based on the preferences they set They can also	Yes User can track the sessions, minutes meditated, amount	Partially Some testimonials of other users	Yes Users have different practices	6	0
Parenting App Dadditude	Yes Easy to use and to find the features.	Yes App gives guidance and means for action through diverse content	Partially Content is specific for dads	Partially User can personalise notifications and filter part of the content according kid's age group (newborn, toddler...)	Partially User can keep track of social interaction features ( comments, posts, likes...)	Partially Some testimonials of other users are available on the website	No	2	4
Parents	Yes Easy to use and to find the features.	Yes App gives guidance through content and some are just available in a logical sequence. Most of the programs are not free though.	Partially Content is specific for parents	Partially User can personalise notifications	Partially	Partially Some stories of other parent's are available	Partially User can use some exercise as part of the a few programs (such as	2	5
The Happy Child Parenting App	yes Easy to use and to find the features. Provide steps to facilitate perform target behavior (emotions list available)	yes app provides guidance. Lessons are just unlocks once user did the first ones.	Partially Content is specific to parents	partially User fills brief information about the children age and the relationship and goals before start using the app but it does not seems the content was	partially User can keep track of tips received, lessons watched and write notes. User can not track the answers for the emotions	Yes Some statistics about the effectiveness of the app are available on the website	no	3	3

## 6. Evaluation Dialogue Support elements – PSD

APP	Praise	Rewards	Reminders	Suggestions	Similarities	Liking	Social Role	Used elements Fully	Used elements Partially
DadPad	no	no	no	no	no	yes app has an appealing	no	1	0
Expectful: Wellness for Moms	Yes User gets praise messages when finishes a practice	No	Yes	Yes User receives suggestion of contents and practices based on	No	Yes app has an appealing design	No	4	0
How To Be A Good Dad (Father)	No	No	no	No	No	Partially App's desing is not much appealing as is mainly long texts. The main page uses somes	No	0	1
Manatee: Family Mental Health	Yes User gets praise written messages and images when finishing a task	Yes User gets rewards when completing goals	Yes User can set reminders for the goals	Yes User receive tips and suggestion of courses	Partially App uses suggestive answer choices that fit what user might be feeling	Yes app has an appealing design with illustrations and animatons	Yes App offers a chatbot functioning as a helping	6	1
Mental health for mom + Social	Partially Only happens if other moms like or comment other user's posts. There is nothing from the app itself	No	Partially There are reminders for events the user subscribe but not engage on the social interaction or	No	No	Yes app has an appealing design	No	1	2
Mindful Mamas: Sleep for Moms	Yes User gets praise messages when finishes a practice	No	Yes User can set reminders for different features	Yes User receives suggestion of contents and practices based on	Yes App uses suggestive answer choices that fit what user might be feeling	Yes app has an appealing design	No	5	0
Parenting App Dadditude	Partially Only happens if other moms like or comment other user's posts. There is nothing from the app	No	Yes User can set reminders for different features	Yes User receive tips	No	Yes app has an appealing design with diverse icons and illustrations	No	3	0
Parents	Yes User gets praise written messages and images when enrolling or finishing a course	No	Yes User can set reminders for different features	No	NO	Yes app has an appealing design with diverse icons and illustrations	Yes App offers a chatbot functioning as a helping	4	0
The Happy Child Parenting App	yes user gets praise written messages and images when finishing a lesson or answering a question correctly	no	yes User can set 2 types of daily reminders and decide time	yes User can set to receives tips	no	yes app has an appealing design	no	4	0

## 7. Evaluation System Credibility Support elements – PSD

APP	Trustworthiness	Expertise	Surface Credibility	Real World Feel	Authority	Third-party endorsement	Verifiability	Used elements Fully	Used elements partially
DadPad	Yes Information unbiased and truthful	Yes Information provided by health professionals	Yes App has a competent look and feel, does not have ads.	Yes It is stated that NHS and health professionals are behind the app	Yes It is stated that NHS and health professionals are behind the app and services are referred on the app	Yes Website mentions receiving funds from European Regional development fund (EU)	No	6	0
Expectful: Wellness for Moms	Yes Information unbiased and truthful. There is no source cited however sites states it is based on scientific	Yes Information provided by a range of health professionals.	Yes App does not have ads and has a competent look and feel	Yes Information about the organization behind it is available and there is a contact channel	Yes Information about the professionals behind the app is available on the app	Yes Website mentions media that app was mentioned (eg Forbes and Vogue)	Yes References and people behind the app can be found on the	7	0
How To Be A Good Dad (Father)	Partially Information seems to be unbiased and truthful, however	No	Partially App has simple look and feel, ads interrupt navigation constantly.	No	No	No	No	0	2
Manatee: Family Mental Health	Partially App provides trustworthy content. However as the app has also the goal to offer	Yes Content is made by health professionals	Yes App has a competent look and feel, does not have ads.	Yes Organization and professionals can be seen within the app and the website and can be	Partially Part of the content name the health professionals responsible	Yes Website mentions several insitutions, such as university and hospital	Yes References and experts behind the app can be found on the	5	2
Mental health for mom + Social	Partially App provides videos and articles with truthful information. Videos are not	Partially App provides videos and articles made/written by experts. Videos are not	Partially App has a competent look and feel, does not have ads but the videos are not working	No The presentation video from the founder is not available anymore	Partially Videos and articles are written/made by professionals but there is no detailed information about them and	No	No	0	4
Mindful Mamas: Sleep for Moms	Yes Information unbiased and truthful. There is no source cited however sites states it is based on research	Yes Content is made by psychologists, mindfulness experts and moms, however they are not named	Yes App does not have ads and has a competent look and feel	Yes Information about the organization behind it is available and there is a contact channel	Yes App has received awards (eg Best guided meditations online 2022)	Yes Website mentions media that app was mentioned (eg Heymama and Parenthood) and prizes received (eg Best	Yes References and people behind the app can be found on the website	7	0
Dadditude	Yes Information unbiased and truthful with sources and authors mentioned	Yes Content created by professionals involved have qualifications on the health area	Yes App does not have ads and has a competent look and feel	Yes Detailed information about the organization and professionals responsible it is available and there is a	Yes App informs qualification, name and picture of the expert for every content within the app	No	Yes Detailed information about experts behind the app can be	6	0
Parents	Yes Information seems to be unbiased and truthful. There is no source cited and the title of the presenter of contents is "trainer" on the institution that	Yes The professionals that create the content has years of experience on the institution	Yes App does not have ads and has a competent look and feel	Yes Information about the organization behind it is available and there is a contact channel	Yes Apps informs the author of the contents and their experience within the organization	Yes Website mentions media that app was mentioned (eg Forbes and TEDx) and companies where users work (Google)	No	6	0
The Happy Child Parenting App	Yes Information unbiased and truthful. There is no source cited however sites states it is based on research on Psychology,	Yes Website mentions it is based on research In Psychology Neuroscience and Pediatrics. App updated recently (less	Yes App does not have ads and has a competent look and feel	Yes Information about the organization behind it is available and there is a contact channel	yes App 's website mentions the non-profit organization behind it and the category of professionals involved ( psychologists, psychiatrists and neuroscientists)	No Third-parties are mentioned endorsing the work of the founders of the foundation behind the app but not the aoo	Yes References and experts behind the app can be found on the website	6	0

## 8. Evaluation Social Support elements – PSD

APP	Social Learning	Social Comparison	Normative Influence	Social Facilitation	Cooperation	Competition	Recognition	Used	Used
								elements Fully	elements Partially
DadPad	No	No	No	No	No	No	No	0	0
Expectful: Wellness for Moms	No	Partially Users can directly share content via social media.	Partially Website has a session with shared stories and interviews of other	No	No	No	No	0	2
How To Be A Good Dad (Father)	No	Partially Users can directly share content via social media.	No	No	No	No	No	0	1
Manatee: Family Mental Health	No	Partially users can directly share some content via social media	no	No	No	No	No	0	1
Mental health for mom + Social	Partially App is a community where users can present share their achieves and react to it (there is no specific incentive to post)	Partially Users can make comparisons based what others post. Besides users can directly share articles and videos via social media	Yes App gathers people with same goals and topic of interest	Yes Main goal of the app is social facilitation, throu adding friends, posting...	Yes Means for cooperation are provided such as adding events, selling/buy, chatting with users...	No	Partially Other users can provide regonition through comments or sending likes	3	3
Mindful Mamas: Sleep for Moms	No	Partially Users can directly share content via social media.	Partially Some testimonials of other users are available	No	No	No	No	0	2
Parenting App Dadditude	Partially App offers a community where users can present their progress and react to it (there is	Partially Users can make comparisons based what others post. Besides users can directly share articles and videos via social media	Yes App gathers people with same goals and topic of interest. Also website has testimonials of other parents	Yes Users can interact with other dads	Yes Means for cooperation are provided such as discussing in the forum with other	No	Partially Other users can provide regonition through comments or sending likes	4	2
Parents	No	Partially Users can directly share content via social media.	Yes App has "life hacks" with stories of other parents	No	No	No	No	1	1
The Happy Child Parenting App	No	Partially Users can directly share content via social media.	Partially App's website give statics of the user's satisfaction (eg 78% of users reported improved relationships with their	No	No	No	No	0	2