

**Web-Assisted Self-Help for Parents of Children with ADHD:
Acceptance and Utilization and their Relation to
Externalizing Child Behaviour Problems**

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List of Abbreviations

ADHD	Attention-Deficit/Hyperactivity Disorder
AUC	Area Under the Curve
BPT	Behavioural Parent Training
CART	Classification and Regression Trees
CD	Conduct Disorder
CFI	Comparative Fit Index
CI	Confidence Interval
DASS	Depression, Anxiety, and Stress Scales
DBCI	Digital Behaviour Change Intervention
DCL-EXT	Diagnostic Checklist for Externalizing Behaviour Disorders
DiGA	Digital Health Applications
DMHI	Digital Mental Health Intervention
DSM	Diagnostic and Statistical Manual of Mental Disorders
FITT	Frequency, Intensity, Time, and Type (of Engagement)
HCP	Healthcare Provider
iCBT	internet-based cognitive behavioural therapy
ICD	International Statistical Classification of Diseases
NUse	Number of logins (<i>frequency of utilization</i>)
ODD	Oppositional Defiant Disorder
OPP	Oppositional Scale
PMT	Parent Management Training
PNPQ	Positive and Negative Parenting Questionnaire
PSB	Prosocial Behaviour Scale
PUse	Percentage of completed tasks/videos (<i>intensity of utilization</i>)
RCT	Randomized Controlled Trial
RMSEA	Root Mean Square Error of Approximation
ROC	Receiver Operating Characteristic
SCL-ADHD	Parent-rated German Symptom Checklist for ADHD
SCL-ODD	Parent-rated German Symptom Checklist, Subscale for ODD and Related Health Problems
SES	Socioeconomic status
SUPPORT	Telephone-based support calls
SPSS	Statistical Package for the Social Sciences

SRMR	Standardized Root Mean Square Residual
TAU	Treatment as usual
WASH	Web-assisted self-help
WHO	World Health Organization

Summary

Summary in English

Parent management training is an evidence-based treatment of children and adolescents with externalizing disorders. Despite its proven effectiveness, face-to-face parent training is often unavailable due to limited resources and frequently suffers from high attrition rates when offered. As a result, many children and their parents do not receive treatment and are therefore exposed to the risks of an untreated behavioural disorder. Online parenting programs have been found to overcome barriers to attendance in behavioural parent training. However, little is known about the characteristics of caregivers of children who engage with web-based parent training and how caregiver utilization is associated with child outcomes. The present thesis aims were (1) to analyze predictors of acceptance and utilization of web-assisted self-help and (2) to relate caregiver utilization to the child's externalizing outcomes.

In a randomized controlled trial, caregivers of children aged 6 to 12 years with elevated levels of externalizing behaviour were allocated to either unguided web-assisted self-help (WASH) or telephone-supported web-assisted self-help (WASH+SUPPORT). The sample consisted of n=276 caregivers who were referred to the study by a healthcare provider and were mostly biological mothers of a higher socioeconomic status. A multidimensional assessment of acceptance and utilization parameters was based on objective measures and complemented with subjective self-assessments. Classification and Regression Trees were conducted to gain insight into utilization-related predictive sociodemographic and socioeconomic characteristics of the caregiver and child, and structural conditions of the intervention (i.e., additional individualized counselling). Moreover, path analyses were conducted to investigate the association between caregiver utilization and changes in the child's externalizing symptoms.

The results provide important insights for the practical implementation of web-assisted self-help in clinical practice, which can guide pediatricians, psychotherapists, and psychiatrists in recommending web-assisted self-help to appropriate target groups. Caregivers greatly accepted the intervention. Factors that prevent caregivers from using the intervention (e.g., highly positive parenting, very severe/mild symptomatology of the child), as well as factors that support caregiver utilization (e.g., telephone-based support), are identified. These results are important to consider, as there is first evidence for the relation between caregiver utilization and caregiver-reported change in ADHD symptoms.

In conclusion, web-assisted self-help is a promising treatment option that could help bridge the gap in service provision. Consistent with previous research, the findings suggest that personal contact may enhance caregiver engagement with the intervention. The findings underline the importance of targeted interventions to enhance adherence. Future research might analyze more complex models,

e.g., including parental psychopathology and parenting as variables to be related to the association of caregiver utilization and child outcomes.

Summary in German

Parent Management Training (PMT) ist eine evidenzbasierte Behandlungsmethode für Kinder und Jugendliche mit externalisierenden Störungen. Trotz der nachgewiesenen Wirksamkeit werden face-to-face-Trainings häufig nicht ausreichend angeboten und werden häufig frühzeitig beendet bzw. nicht vollständig absolviert. Dadurch erhalten viele Kinder und ihre Eltern keine adäquate Behandlung und bleiben den Risiken unbehandelter Verhaltensstörungen ausgesetzt. Online-Elternprogramme haben sich als effektiv erwiesen, um Barrieren für verhaltenstherapeutisches Elterntaining zu überwinden. Ziel der vorliegenden Arbeit ist es, Prädiktoren für die Akzeptanz und Nutzung von webbasierten Selbsthilfeprogrammen zu analysieren und die Zusammenhänge zwischen der Nutzung durch die Eltern und der Veränderung des externalisierenden Verhaltens des Kindes zu untersuchen.

In einer randomisierten kontrollierten Studie wurden Eltern von Kindern im Alter von 6 bis 12 Jahren mit erhöhten externalisierenden Verhaltensweisen entweder der unbetreuten webbasierten Selbsthilfe (WASH) oder der telefonunterstützten webbasierten Selbsthilfe (WASH+SUPPORT) zugewiesen. Die Stichprobe umfasste 276 Familien, die von einem Facharzt für Kinder- und Jugendmedizin oder einem Facharzt für Kinder- und Jugendpsychiatrie für die Studie rekrutiert wurden. Die Teilnehmenden waren überwiegend biologische Mütter mit höherem sozioökonomischem Status. Eine mehrdimensionale Beschreibung von Akzeptanz- und Nutzungsparametern basierte auf objektiven Messungen und wurde durch subjektive Selbsteinschätzungen ergänzt. Klassifikationsregressionsbäume (CART) wurden verwendet, um die Nutzung anhand soziodemografischer und sozioökonomischer Merkmale der Betreuungsperson und des Kindes sowie struktureller Bedingungen (z.B. individualisierte Beratung) vorherzusagen. Zusätzlich wurden Pfadanalysen durchgeführt, um die Zusammenhänge zwischen der Nutzung durch die Eltern und der Veränderung der externalisierenden Symptome des Kindes zu untersuchen.

Die Ergebnisse liefern wichtige Erkenntnisse für den praktischen Einsatz von webbasierten Selbsthilfeprogrammen in der klinischen Praxis. Diese Erkenntnisse können von Pädiatern, Psychotherapeuten und Psychiatern genutzt werden, um webbasierte Selbsthilfeprogramme einer geeigneten Zielgruppe effektiv zu empfehlen. WASH wird von Eltern sehr gut akzeptiert. Es wurden Faktoren identifiziert, die die Nutzung der Intervention durch die Eltern hemmen (z.B. sehr positive Erziehungsstrategien, sehr schwere oder sehr leichte Symptomatik des Kindes) sowie Faktoren, die die Nutzung durch die Eltern fördern könnten (z.B. telefonische Unterstützung). Diese Ergebnisse sind wichtig, da erste Hinweise auf den Zusammenhang zwischen der elterlichen Nutzung und der von den Eltern berichteten Symptomveränderungen der kindlichen ADHS vorliegen.

Zusammenfassend erscheint WASH eine wertvolle Behandlungsoption, die Versorgungslücken schließen könnte. Im Einklang mit früheren Forschungen kann persönlicher Kontakt dazu beitragen, den Abbruch der Intervention zu verhindern. Die Ergebnisse unterstreichen die Bedeutung gezielter Interventionen zur Verbesserung der Adhärenz. Zukünftige Forschung sollte komplexere Modelle untersuchen, wie etwa die Rolle von elterlicher Psychopathologie und Erziehungsstilen als zusätzliche Variablen, die den Zusammenhang zwischen der Nutzung durch die Eltern und den externalisierenden Symptomen des Kindes beeinflussen könnten.

1 Introduction

In Europe, only 25.6% of children with a substantial need for mental health care (because of clinically significant psychiatric symptoms) receive help from a specialist (Husky et al., 2020). According to the Lancet, we have to expect a global mental health crisis traced back to the COVID-19 pandemic (The Lancet Infectious, 2020): the consequences of the COVID-19 pandemic (e.g., due to school closings and social isolation) have led to an increased prevalence of mental health problems in children and adolescents, as well as parental stress and family challenges (Fitzpatrick, Carson, & Weisz, 2020; Ravens-Sieberer et al., 2020). More than ever, research indicates a critical need for evidence-based, cost-effective approaches to improve the availability and accessibility of mental health services for parents and children. Digital healthcare treatment, with a history of more than 25 years (Lattie, Stiles-Shields, & Graham, 2022), has been found to address these social challenges. For child and adolescent treatment, online parent training, such as the German web-assisted self-help (WASH) for caregivers of children with externalizing disorders, has been found to be effective (Döpfner et al., under review).

The aim of the present cumulative doctoral thesis is to explore factors affecting the acceptance and utilization of a WASH intervention and analyze their relation to the intervention's effects on children's externalizing problems (Wähnke et al., 2024; Wähnke et al., in press 2024).

Chapter 1 provides the theoretical background, covering general information on externalizing childhood disorders, multimodal evidence-based treatments, including parent management training, and the barriers to attending and completing parenting interventions. Moreover, promising alternatives to overcome these obstacles and web-based self-help as a special form of Digital Mental Health Intervention (DMHI) are described. Empirical findings and theoretical background on the acceptance and utilization of DMHIs are presented. An overview of the WASH study, from which the data for the current analyses were taken, is given. Finally, the objectives of this doctoral thesis are outlined.

Chapter 2 is a publication of a paper on the multidimensional description of the acceptance and utilization of WASH and analyses on the prediction of acceptance and utilization of WASH by caregiver- and child-related factors (Wähnke et al., 2024).

Chapter 3 contains a publication on path analyses to relate caregiver utilization to the changes in child externalizing symptoms, differentiating between early and late treatment (Wähnke et al., in press 2024).

Chapter 4 discusses the scientific findings presented in the publications, including the strengths and limitations of the analyses. Subsequently, the clinical implications of the results, as well as future directions for research, will be reflected and conclusions of the findings will be derived.

Additional files to complete this work, such as additional tables and figures that are not displayed in the main body of this thesis, are presented at the end of this thesis (Chapter 5).

1.1 Classification and Prevalence of Externalizing Childhood Disorders

Externalizing behaviour disorders in childhood comprise a group of disorders characterized by a range of socially undesirable behaviours that disregard norms and rules in the context of school, family, and/or peers and are associated with interferences in functioning and development (American Psychiatric Association, 2022; World Health Organization, 2019). These commonly include Attention-Deficit/Hyperactivity Disorder (ADHD), Oppositional Defiant Disorder (ODD), and Conduct Disorder (CD).

The worldwide prevalence of mental disorders in children and adolescents in general is about 13% (Polanczyk, Salum, Sugaya, Caye, & Rohde, 2015). With estimates of 3.4% (CI 95% [2.6–4.5]) for Attention-Deficit/Hyperactivity Disorder (ADHD) and 5.7% (CI 95% [4.0–8.1]) for disruptive behaviour disorders (ODD and CD), externalizing disorders belong to the most common psychiatric diagnoses during childhood (Polanczyk et al., 2015). In addition to children with manifest mental disorders, 5% of children and adolescents have been described to demonstrate substantial difficulties in a subclinical range (Sayal, Prasad, Daley, Ford, & Coghill, 2018). A recent systematic review and meta-analysis indicates that the prevalence of ADHD has increased over the last years, to 7.6% for children (3 to 12 years of age) and to 5.6% for teenagers (12 to 18 years of age) (Salari et al., 2023). With a comorbidity rate of 20%, ODD is likely to co-occur (Reale et al., 2017). Regarding the prevalence, it remains to be considered that discrepancies in the results often occur due to inconsistent measurements (e.g., DSM and ICD criteria) as well as due to different age groups analyzed (Salari et al., 2023).

Attention-Deficit/Hyperactivity Disorder. ADHD, in the 11th edition of the International Classification of Diseases (ICD-11), is defined by elevated levels of inattention, hyperactivity, and/or impulsivity (World Health Organization, 2019). Typical examples of *inattention* are carelessness, dreaminess, or problems with self-organization, leading to missing school materials or losing personal items. It is important to note that children and adolescents can be attentive despite an ADHD diagnosis, especially, for example, when continuous reinforcement (e.g., in computer games) takes place. *Hyperactivity and impulsivity* often become apparent in structured everyday situations where behavioural self-control is required (World Health Organization, 2019). They include, e.g., excessive physical or verbal agitation, frequent disruptive behaviour/interrupting, and making rash decisions. These problems occur in different areas of life over a period of at least six months. For a confirmed diagnosis, the symptoms should have appeared in early to middle childhood age. However, in earlier versions of ICD and DSM, symptoms had to be reported and appeared before the age of 12 years (DSM) and before six years (10th edition of the ICD). It is important to note that according to the ICD-11, the symptoms must be present at a developmentally inappropriate level and have a direct negative impact on school or social functioning. With the introduction of the ICD-11, the diagnostic criteria of DSM and ICD have become more aligned, including the classification of ADHD as a neurodevelopmental

disorder, which is defined by the core symptoms of inattention, hyperactivity, and impulsivity (American Psychiatric Association, 2022; World Health Organization, 2019). However, the classification systems are not completely congruent regarding the specific symptoms.

Oppositional Defiant Disorder. The diagnostic term ODD refers to the combination of markedly defiant, unyielding, and disobedient behaviours. This pattern of behaviours is inappropriate for individuals of comparable age, developmental level, gender, and sociocultural context. Typically, ODD is characterized by persistent difficulties in getting along with others (e.g., conflicts with authority figures, demonstrative disregard or refusal to follow rules), as well as by provocative behaviours and extreme forms of irritability or anger (e.g., age-inappropriate exceptionally violent and prolonged outbursts of anger) (American Psychiatric Association, 2022; World Health Organization, 2019). In contrast to CD, ODD is not characterized by cold aggression and disregard and violations of rules (Burke, Evans, & Carlson, 2022). However, children with ODD have an increased risk of developing CD as well as antisocial personality disorders (Hamilton & Armando, 2008). Equivalent to the diagnosis of ADHD, oppositional symptoms must be prevalent over a period of six months and negatively affect an individual's academic, social, or occupational functioning.

Research has found a high co-existence of symptoms of ADHD, ODD, and/ or CD (Azeredo, Moreira, & Barbosa, 2018). According to Azeredo and colleagues (2018) there is a predisposition for children with ADHD to display behaviours that are related to ODD and CD, encompassing the antisocial conduct which is often observed in these individuals. For ADHD and ODD, the comorbidity lies at 60%, and for ADHD and CD, at up to 20% (Azeredo et al., 2018). Shared genetic influences have been found to be relevant for the high comorbidity of these disorders (Azeredo et al., 2018). During childhood, ADHD has been found to be highly heritable, driven by familial factors (Tistarelli, Fagnani, Troianiello, Stazi, & Adriani, 2020). Expectedly, children with ADHD suffer from a reduced quality of life with an impact on psychosocial, school, emotional, and social domains (Wanni Arachchige Do et al., 2023). The most affected domain for children with ODD symptoms is the family environment (Azeredo et al., 2018). Moreover, a diagnosis of ADHD has been found to be associated with an increased likelihood of the child experiencing victimization and bullying (Lebowitz, 2013). Children and adolescents with ADHD have a significantly increased risk of educational failure, interpersonal problems, mental illness, and delinquency as they develop, resulting in significant burdens for the affected persons and their families, as well as increased costs in healthcare, social welfare, and criminal justice systems (Sonuga-Barke et al., 2013). Untreated externalizing disorders can result in severe consequences, as research indicates significantly worse academic, occupational, and social functioning in these individuals compared to those without symptomatology (Erskine et al., 2016).

To diagnose externalizing disorders, a multimodal approach based on the assessment and integration of information from caregivers, educational specialists, if applicable, adolescents, and

specialized clinicians is essential (Faraone et al., 2021). This diagnostic approach combines clinical explorations and observations as well as the use of standardized rating scales (Döpfner, Hautzinger, & Linden, 2020). While broadband measures help to comprehensively assess both emotional and behavioural symptoms, disorder-specific measures are important to substantiate a diagnosis and to aid in differential diagnostics. In addition to cross-disorder assessment, a strict disorder-specific diagnostic approach is important to differentiate similar symptomatology, e.g., anxiety or learning disorder, with the aim of delivering evidence-based treatment.

1.2 Evidence-based Treatment of Externalizing Childhood Disorders

To reduce and prevent the negative impact of externalizing disorders on family, school, or social functioning and increase the participation and inclusion of the affected child/ adolescent in societal structures, specific and effective treatment as early as possible is needed (Gorman et al., 2015). Consistent multimodal treatment, which is known as the combination of different treatment modules based on the child and family's individual needs and context, has been recommended in international and national guidelines (Deutsche Gesellschaft für Kinder- und Jugendpsychiatrie, 2018; Drechsler et al., 2020; National Institute for Health and Care Excellence, 2019; Taylor et al., 2004). Psychosocial interventions are recommended according to German and international guidelines (Deutsche Gesellschaft für Kinder- und Jugendpsychiatrie, 2018; National Institute for Health and Care Excellence, 2019; Taylor et al., 2004).

Parent Management Training. Caregiver-directed behavioural interventions are of particular importance in the treatment of children aged 6-12 years (Posner, Polanczyk, & Sonuga-Barke, 2020). Regarding the treatment of preschool-age children, there is a consensus to start with parent management training (PMT) aimed at behaviour management unless the child's symptoms are very severe or the child is a non-responder to PMT (Posner et al., 2020). The aim of PMT is to modify ineffective parenting techniques, enhance positive parent-child interactions, and address the underlying neuropsychological issues associated with ADHD (Abikoff et al., 2015). Behavioural PMT relies on cognitive behavioural techniques, such as learning to give effective commands and applying contingency management strategies (Chronis, Chacko, Fabiano, Wymbs, & Pelham, 2004).

As rated by parents, PMT has been found to significantly reduce ADHD and ODD symptoms in children in meta-analyses (Dekkers et al., 2022; Groenman et al., 2022; Mingeback, Kamp-Becker, Christiansen, & Weber, 2018; Rimestad, Lambek, Zacher Christiansen, & Hougaard, 2019) and systematic reviews (Fabiano, Schatz, Aloe, Chacko, & Chronis-Tuscano, 2015). Apart from reducing ODD and noncompliant behaviours, meta-analyses have found PMT to improve aspects of child functioning (Daley et al., 2018), parenting (Daley et al., 2014), and parental stress (Ciesielski, Loren, & Tamm, 2020). Changes in child externalizing problem behaviour following PMT were found to be mediated by a reduction of negative parenting practices in problematic parenting situations as well as

by an increase in positive parenting practices (Hanisch, Hautmann, Plück, Eichelberger, & Döpfner, 2013). These effects could not be fully replicated in “probably blinded” outcomes (Daley et al., 2014; Sonuga-Barke et al., 2013). However, research indicates divergent results on the proof of effects of non-pharmacological treatment for ADHD, as the beneficial effects of a group intervention for caregivers were found in parent ratings as well as observed measures of child behaviours (Furlong et al., 2012).

Child-directed Interventions. Treatment directed at the child includes pharmacological (Dalrymple, Maxwell, Russell, & Duthie, 2020) and non-pharmacological treatments (Catalá-López et al., 2017). Although there is evidence for the efficacy of pharmacological treatment in children and adolescents, especially in the short term, as measured in randomized-controlled trials (RCT), as first-line treatment, most organizations recommend psychoeducation and behavioural PMT (Posner et al., 2020).

It is generally agreed that no ground-breaking findings have been made in recent decades to improve the effectiveness of psychosocial therapy for ADHD (Weisz et al., 2018). Parent management training is therefore increasingly becoming the focus of research on the improvement of child ADHD treatment (Hornstra et al., 2023; van der Oord & Tripp, 2020).

1.3 Barriers to Caregiver Participation in Parent Management Training

Despite these recommendations and evidence for the efficacy of PMT, regular participation in behavioural parent training and complete participation is often not given. According to research on the Chicago Parent Program for parents of young children, of those caregivers that did sign up to participate in the intervention, one-third did not attend a first session (Breitenstein et al., 2012). Moreover, attendance rates in PMT after signing in for participation range between 35% to 50% (Heinrichs, Bertram, Kuschel, & Hahlweg, 2005). This gap between children needing treatment and children receiving treatment has been addressed by McGoron and Ondersma (2015), trying to find individual characteristics of caregivers that are associated with the likelihood of dropping out of PMT, concluding that it is not a single characteristic but potentially a combination of different factors.

Reardon et al. (2017) identified four aspects of barriers that prevent caregivers from attending parent management interventions:

- I. There are systematic and structural facilitators associated with the mental health system (e.g., lack of availability, waiting times, and cost of services).
- II. Caregivers' attitudes towards mental health services, the treatment, and/or the provider (e.g., effectiveness, perceived possible consequences for the child), including fear of stigma.
- III. A lack of understanding of mental health problems (e.g., severity and consequences of untreated disorders) and no knowledge about the opportunity to seek professional help.

- IV. Individual family circumstances such as other responsibilities (e.g., occupational) and limited support networks (e.g., childcare during participation) limit the accessibility of face-to-face treatment options.

Innovative forms of PMT (e.g., telephone-based self-help) may overcome some of the known barriers (Friars & Mellor, 2009). Furthermore, during the COVID-19 pandemic, these obstacles even increased, as most in-person treatment was stopped in general, and parent training conducted in groups was canceled (Fegert, Vitiello, Plener, & Clemens, 2020). Therefore, the European ADHD Guidelines Group specifically (amongst others) recommended self-help versions to improve treatment accessibility (Cortese et al., 2020). Apart from its relevance during pandemic circumstances, guided self-help interventions have previously been found to achieve small to large effects (comparable effects to face-to-face PMT) on child externalizing outcomes (Bennett et al., 2019) and small to moderate effects on caregivers' parenting in caregiver ratings (Tarver, Daley, Lockwood, & Sayal, 2014).

1.4 Digital Mental Health Interventions and eHealth: Definition, formats, and their relation to mental health symptoms

Digital interventions in health care are a rapidly growing field, and various terms can be found in the literature that describe these interventions. The World Health Organization (WHO) defines *eHealth* as the “secure use of information and communication technologies in support of health” (World Health Organization, 2021). According to the definition of the WHO, the term *Digital Health* extends the concept of *eHealth*, as Digital Health involves the implementation of diverse smart devices and equipment as well as the implementation of robotics and artificial intelligence (World Health Organization, 2021). In the following, the summary term *Digital Mental Health Intervention* (DMHI) is used to describe the different types and formats of delivering online interventions in the field of mental health. Generally understood, DMHIs “deliver psychological strategies and interventions via online and/or mobile platforms” (Lattie et al., 2022, p. 78).

DMHIs have been developed and implemented in the last 25 years, with formats ranging from (I) unguided or self-guided (i.e. independently using the intervention), (II) guided by a human (coach or therapist) (via telephone or internet) to (III) a combination of DMHI with face-to-face treatment (Lattie et al., 2022). A very large target group can access unguided interventions as human resources do not limit their attendance and as it is cheaper for individuals and/or healthcare systems than interventions involving coach or therapist contact (Lattie et al., 2022). However, research indicates that guidance by a human (II), e.g., telephone-based support by therapists, improves adherence and motivation (Day & Sanders, 2018; Tarver, Daley, & Sayal, 2021) and enhances its effectiveness (Lattie et al., 2022). The WASH study (Döpfner et al., under review) supports these findings (cf. Chapter 1.5). Some research highlights that the profession of the guiding human may be irrelevant, as found in an

RCT that compared technician-assisted (non-specialist professional) internet-based cognitive behavioural therapy (iCBT) versus clinician-assisted iCBT with a wait-list control group yielded no significant differences in terms of effectiveness in the treatment of depression (Titov et al., 2010). A sub-analysis of meta-analyses on the efficacy of online PMT for caregivers of children and adolescents with behavioural problems revealed that online parenting interventions, which offered technical support, demonstrated comparable effectiveness to those providing specialized advice for both children and parents' outcomes (Florea, Dobrea, Păsărelu, Georgescu, & Milea, 2020). In a meta-analysis on PMT, self-guided interventions, including clinical support (e.g., content experts, therapists) compared to mere self-help, revealed no significant differences regarding child externalizing and internalizing symptoms and parental outcomes (Spencer, Topham, & King, 2020). In summary, to date, there is no consensus on the effects of additional support services in the context of web-based self-help/ DMHI. However, as mentioned, the WASH results indicate that there may be beneficial effects of additional support (cf. Chapter 1.5).

The use of the combination of DMHI with face-to-face interventions (III), the so-called “blended approaches”, e.g., for symptom assessments, skill practice, or communication, is increasing and in the focus of therapists as this seems to be a promising complement to psychotherapy (Lattie et al., 2022; Schuster, Topoco, Keller, Radvogin, & Laireiter, 2020). However, a recently published German cross-sectional evaluation of the current use of eHealth and experiences of adult health care providers (e.g., psychotherapists, specialists, general practitioners; $N=425$) describes difficulties in implementing eHealth into treatment: although the majority had heard of e-mental health interventions (83.8%), only 28.5% had already implemented them into their therapeutic practice or recommended them to their patients. None of the providers (no specialist in psychiatry or medicine) had recommended a self-help intervention; all recommended interventions were directed at affected individuals (Weitzel et al., 2023).

For adults with depression, an association between site usage (in %) of the *MoodGYM intervention* and individuals self-reported depression and anxiety symptoms (Christensen, Griffiths, & Korten, 2002). In line with this, in the context of digital interventions, there is empirical evidence that reliable change is associated with more frequent and more intensive use of a program (Enrique, Palacios, Ryan, & Richards, 2019).

To conclude, the Internet has been found to be a promising medium to offer easily accessible and cost-effective self-help interventions to meet the dramatically increased need for specialized mental health services in general (Mohr, Riper, & Schueller, 2018; Ravens-Sieberer et al., 2020). Present interventions – when used – have been found to be related to a decrease in user's symptoms. However, there seem to be barriers in the allocation of eHealth interventions. Moreover, there is still

a lack of clarity about how programs are used, how usage can be increased, and what can be done to counter the typically high dropout rates.

1.5 Web-assisted Self-Help for Parents in the Treatment of Childhood Disorders

In a meta-analysis, most of the internationally available online parenting programs addressed problem behaviours (Thongseiratch, Leijten, & Melendez-Torres, 2020). For externalizing disorders, the most commonly known programs are *Triple P Online* for parents of children with disruptive behaviours aged 2-9 years (Sanders, Baker, & Turner, 2012), the *Strongest Families Smart Website* for treating disruptive behaviours of 4-year olds (Sourander et al., 2016), and the preventive *ezParent* (adapted Chicago Parent Program), which particularly addresses low-income families of 5-year olds (Breitenstein et al., 2012; Breitenstein, Schoeny, Risser, & Johnson, 2016). Other parenting programs, e.g., the prevention program *Parenting Resilient Kids*, address caregivers of children in risk of depressive and anxiety disorders (Sim, Jorm, & Yap, 2022), or the *Cool Little Kids Online* for parents of children (3-6 years) with anxiety (Morgan, Rapee, Salim, & Bayer, 2018).

Some parents even reported a preference for online programs compared to face-to-face treatment for delivering parenting information on children's mental health, especially in school-aged children (Sim, Jones, Jorm, & Yap, 2017). For the Parenting Resilient Kids program, parental engagement was not found to be associated with a change in caregiver-rated child anxiety or depressive symptoms. However, a stronger orientation towards the recommended use of the program (i.e., task completion) predicted caregiver-rated preventive parenting (Sim et al., 2022). Furthermore, self-reported skills practice during the *Cool Little Kids* online program was found to be associated with a decrease in child anxiety symptoms (Morgan et al., 2018).

The WASH intervention. The WASH intervention (Schürmann, Döpfner, & AOK-Bundesverband, 2017), which is the focus of this thesis, has been developed based on evidence-based written behavioural therapy manuals (Döpfner, 2019) and self-help booklets (Dose et al., 2017). The Allgemeine Ortskrankenkasse (AOK, health insurance) offers the intervention free of charge to the public. The program is aimed at parents of children aged six to twelve to reduce difficult parenting situations and children's behavioural problems.

WASH consists of four modules that can be accessed based on an individual's preferences without any restrictions (Döpfner, Wähnke, et al., 2020; Wähnke et al., 2024): (1) psychoeducation ("ADHD – What is it?"), (2) a positive relationship with your child, (3) self-care for parents, and (4) solving behavioural problems. The psychoeducation module (1) provides users with general information on ADHD, including characteristics of ADHD, etiological evidence, and prejudices regarding pharmacological treatments that are dispelled based on current scientific evidence. The intervention is based on a positive caregiver-child relationship; therefore, the second module (2) teaches caregivers to perceive positive situations with and characteristics of the child and guides caregivers to improve

the relationship. In the third module (3), parents are motivated to recognize and consider their own needs and find time for self-care. The fourth module (4) teaches users in seven steps, accompanied by short video sequences, on how to deal with their individual problematic situation with their child. The module includes *antecedent-based techniques*, e.g., to provide clear instructions and clarify target behaviour in certain situations using effective prompts. Furthermore, by reinforcing desirable behaviour, caregivers are coached with techniques aiming at behaviour change (positive consequences, e.g., praise, social reinforcers) and reducing undesirable behaviour through natural or negative consequences (e.g., compensation; *contingency management* techniques). These contingency management techniques are based on the principles of operant procedures, a basis of the psychology of learning (Dadds & Tully, 2019). Users are provided with seven typical situations, e.g., media consumption, restlessness during meals, temper tantrums, and problems with homework, to personalize the application. Each of the seven situations includes the same seven steps of training. The intervention includes a section called “My space” where additional material can be found to transfer strategies into everyday life, e.g., downloadable worksheets. Didactically, various methods are used that supplement pure information providing with active processing of the program. There are (i) short video sequences, (ii) audio examples, e.g., effective prompts, self-assessment via (iii) radio button and (iv) interactive text tasks.

In the intervention itself, no specifications are made for use. However, in the section “How do I proceed?” users are told to use the intervention daily or weekly, depending on their individual time. Modules are described as equally important and can be used independently of each other. Users are asked to choose the module that interests them most and is most important to them. It is recommended to complete the chosen modules in the order provided and to complete the interactive tasks. Orientation time values for the expected processing time for a module are given. The section also serves as a motivational orientation and points out that changes take time to prevent frustration (Schürmann et al., 2017). If registered by e-mail address, users can save their process during the intervention and choose to receive e-mail-sent reminders.

Effectiveness of web-based parent training. Systematic reviews report that web-based parent training is effective in reducing problem behaviour, with small to moderate effect sizes (Baumel, Pawar, Kane, & Correll, 2016; Baumel, Pawar, Mathur, Kane, & Correll, 2017; Breitenstein, Fogg, Ocampo, Acosta, & Gross, 2016; Daley et al., 2018; Sourander et al., 2016; Wähnke et al., 2024). In addition to improving child behaviour problems, in meta-analyses, online PMT has been found to be effective in improving parental outcomes such as parenting behaviour, parent distress, and parenting efficacy (Flores et al., 2020). An RCT to evaluate the efficacy of an online self-help program in $N=53$ parents of pre-schoolers with ADHD symptoms revealed significant improvements in mother-rated child outcomes and positive parenting (Franke, Keown, & Sanders, 2020). The WASH, which is the basis

of this work, has been proven effective in the WASH study (see Chapter 1.8) in reducing blinded-clinician-rated externalizing child symptoms with small effect sizes (Döpfner et al., under review). However, these results have only been found when combined with additional telephone-based support (Döpfner et al., under review): children of caregivers with additional support revealed stronger symptom reduction than children of caregivers without additional support. Moreover, WASH has been proven to reduce negative parenting behaviour (Döpfner et al., under review).

1.6 Concepts of Utilization in Digital Health Care

Although research supports the benefits of internet-delivered self-help, for 20 years now, the *Law of Attrition* (Eysenbach, 2005) has pointed out the fact that a significant proportion of eHealth users have discontinued the use of the intervention. For instance, in a web-based self-help program for panic disorder, only 1% of the participants completed the 12-week intervention (Farvolden, Denisoff, Selby, Bagby, & Rudy, 2005). Additionally, in the evaluation of *MoodGym* (in a naturalistic condition), only 0.5% of the participants completed all 5 modules (Christensen, Griffiths, Korten, Brittliffe, & Groves, 2004). Obviously, to be successful in reducing mental illness, the eHealth intervention needs to be used (Chiu & Eysenbach, 2010). While the thesis focuses on the description and aspects of utilization and how this is associated with child externalizing outcomes, it is important to look at the current theoretical and empirical background of utilization.

Previous research has used a range of different terms to describe the utilization. Some of these terms, e.g., usage and utilization, might be used interchangeably. However, others differ slightly in their meaning: Different terms for identical or related concepts are used synonymously and operationalized heterogeneously in the literature, including adherence, compliance, usage behaviour, uptake, or engagement (Chiu & Eysenbach, 2010; Perski, Blandford, West, & Michie, 2017). Objective utilization measures typically concentrate on temporal elements, such as how often and for how long users engage with an intervention, as well as the extent to which specific intervention content is used as a percentage of the total (Couper et al., 2010; Perski et al., 2017). Nevertheless, this simplified approach has faced criticism because it fails to provide a complete view of user engagement (Short et al., 2018; Wähnke et al., 2024). For instance, some users may remain logged in for extended periods but make minimal progress. Consequently, researchers have called for a multidimensional approach, referred to as the FITT categories, encompassing the dimensions of frequency, intensity, time, and type of engagement. These dimensions offer a more detailed understanding of the behavioural aspects associated with an intervention's effectiveness. The type of engagement can further be categorized as either active (e.g., self-monitoring and writing) or passive (e.g., merely viewing the intervention content without active interaction; Short et al., 2018; Wähnke et al., 2024).

Utilization, in the present thesis, has been defined in terms of frequency (i.e., number of logins) and intensity (i.e. percentage of completed tasks/videos) of utilization and described as a multidimensional rather than a unidimensional concept (Wähnke et al., 2024).

1.7 Concepts of Acceptance in Digital Health Care

There are different ways to assess and measure user acceptance of digital interventions based on subjective self-assessment or objective automatic data tracking (cf. Wähnke et al., 2024). Before the introduction of objective data tracking methods, studies relied on users' subjective ratings, which means that previous research may lack accuracy, potentially leading to either exaggerated or underestimated reports of how interventions are accepted and used (Boase & Ling, 2013). Nevertheless, these subjective measures are frequently employed alongside objective data to provide a more comprehensive assessment (Boase & Ling, 2013). In response to the inconsistent use and definition of the term acceptance, Rost and his team concluded that acceptance is not a quick, one-time event but rather a gradual process that involves acknowledging, experiencing, and feeling content with it (Rost et al., 2017). They recommend assessing user acceptance by indirect measures (e.g., take-up rate, dropout rates) and direct measures (e.g., questionnaires, qualitative methods) based on a longitudinal design.

Other research groups interpret acceptance in the context of intervention satisfaction, making it challenging to compare research outcomes related to the acceptance of (online) PMT. For instance, a recent study that investigated Behavioural Parent Training (BPT) supplemented with support by a child-therapist resumed high levels of acceptance based on caregivers' satisfaction, as indicated by responses on whether an individual's expectations of the treatment and their personal needs were met. Caregivers themselves rated items on their satisfaction with mean scores ranging from 3.8 to 4.9 on a five-point Likert scale (Edelstein, Sullivan, & Becraft, 2023).

In general, there does not yet appear to be a consensus on the best practices for defining and assessing patient or user acceptance in the context of internet- or mobile-based health interventions (Uncovska, Freitag, Meister, & Fehring, 2023). The theoretical and empirically supported *Theory of Acceptance and Use of Technology* with *Performance expectancy* theory was developed based on common theories in psychology (e.g. theory of reasoned action, theory of planned behaviour and social cognitive theory) (Uncovska et al., 2023). It considers an individual's belief, that an intervention will improve their performance, as the main predictor of technology acceptance (Uncovska et al., 2023; Venkatesh, Morris, Davis, & Davis, 2003). Research on parenting programs has also found self-efficacy and parental confidence to be predictive of child externalizing symptoms (Day et al., 2021).

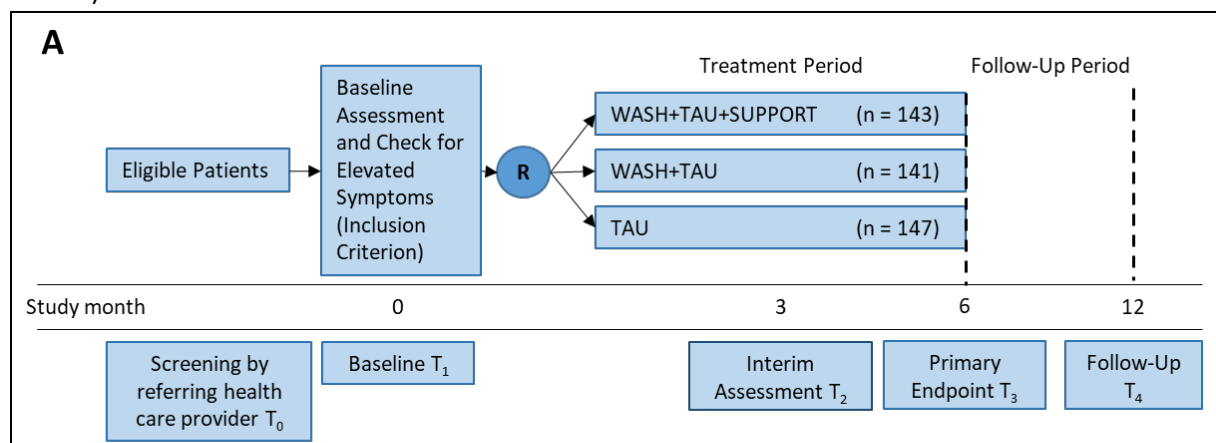
In the present thesis, based on previous literature, the term acceptance relates to the uptake rate (i.e., the percentage of caregivers that log in at least once) and the return rate (i.e., the percentage of caregivers that return for a second session) of the web-based self-help intervention (Breitenstein et

al., 2012; Chiu & Eysenbach, 2010; Rost et al., 2017). Moreover, subjective measures were applied to demonstrate the variability regarding the multi-facets of acceptance, which are reflected in the diverse study definitions (Wähnke et al., 2024).

1.8 The WASH Study

The analyses presented in this thesis are based on the data of a three-arm RCT (see Figure 1) on the efficacy of WASH for parents of children with externalizing disorders under routine care conditions (Döpfner, Wähnke, et al., 2020). Within the WASH Study, three study conditions were compared: Treatment as usual (TAU), unguided self-help (WASH), and WASH with telephone-based support (WASH+SUPPORT). The WASH intervention is aimed at reducing externalizing behaviours (ADHD and ODD) as a potential improvement of treatment as usual by the health care professional. The recruitment of study participants took place from December 2017 to March 2019.

Figure 1. Overall design of the research project (Döpfner et al., 2020; figure from Döpfner et al., under review)



Note. R=Randomization, WASH=web-assisted self-help, TAU=treatment as usual, SUPPORT=telephone based support by a specialist

Data from $n=276$ participating caregivers and children in the two active study conditions (WASH and WASH+SUPPORT) were used in the analyses of this thesis, including three assessment points (T1, T2, T3) of caregiver (child externalizing symptoms, parental psychopathology, parenting) and clinician ratings (child externalizing symptoms). The two intervention periods last three months each (T1-T2 and T2-T3). Participating caregivers were given recommendations on how to process the content. These recommendations were provided together with the login information after T1 (e.g., the recommended number of logins, a special focus for each session, and the duration of twelve-week intervention usage).

The research project was conducted at the University Hospital of Cologne (Germany) and funded by the Innovation Fund of the German Statutory Health Insurance Companies (“Innovationsfonds der Krankenkassen”). WASH has been registered at the German Clinical Trials Register (identifier: DRKS00013456) and approved by the Ethics Committee of the University of Cologne’s Medical Faculty.

1.9 Objectives of the Present Thesis

Due to the amount and variety of interventions – in fact, some of these are chargeable – and some of these are so far untested, there is a need for further investigations, especially on their effectiveness and potential risks (Cortese et al., 2020). Without understanding how and by whom digital interventions are used, there is a risk of worsening the disparity in access to health care (Torous, Jän Myrick, Rauseo-Ricupero, & Firth, 2020), creating new barriers to those in urgent need (Bringewatt & Gershoff, 2010). In the meantime, there is consensus about the effects and cost-effectiveness of these digital interventions. However, there is a particular research gap regarding the German supply structures of digital eHealth and online PMT for externalizing childhood disorders.

This results in the overall purpose of this dissertation: to obtain knowledge of whom the intervention appeals to, who accepts web-assisted self-help, to what extent it is used, and how this relates to the child's symptom change.

The first publication aimed to descriptively explore the frequency and predictors of acceptance and utilization of WASH (Wähnke et al., 2024). The Classification and Regression Trees (CART) method was conducted to predict the acceptance and utilization of WASH. CART enables researchers to obtain a broad overview of multiple predictive factors in one analysis. We included sociodemographic variables of the participating child and caregiver, the child's externalizing symptoms and child competencies, the caregiver's psychopathology (depression, anxiety, and stress), and the caregiver's positive and negative parenting strategies as possible predictors based on previous research on digital behaviour change interventions (DBCI) (Perski et al., 2017).

Previous research points to the dependence of acceptance and utilization on specific factors, such as age and educational attainment, in adult-addressed interventions (Perski et al., 2017). Potential barriers to the utilization of web-based PMT are, for example, the presence of siblings during the intervention (Tarver et al., 2021). There is a lack of reliable empirical findings on the direct influence individual variables (e.g., socioeconomic status) may have on the use of web-based interventions for disruptive childhood behaviour (Baumel et al., 2017). Previous qualitative research on the barriers to engagement with an online parent self-help intervention revealed caregiver-reported factors such as household, other children's needs in the household, and the child's high ADHD symptomatology (Tarver et al., 2021). Results on face-to-face PMT for caregivers of children with conduct problems showed the following predictors to be associated with attendance: parent socioeconomic status (SES), single parent status, and ethnicity (Baker, Arnold, & Meagher, 2011). For SES, the results indicated that higher SES families tended to enroll in a PMT rather than lower SES families. Contrary, SES was not found to be associated with the attendance rates. Dual parents attended significantly more sessions than single parents. Parent depressive symptoms and social support were not found to be associated with attendance.

To the best of our knowledge, no study has analyzed the relations between parental utilization and child symptoms in the field of web-based PMT for child externalizing behaviours to date. The few available studies differ in the kind of intervention, the target group (affected individuals, mostly adults vs. parents), the operationalization of treatment utilization, and outcome measures (Short et al., 2018). Moreover, also research analyzing moderators of PMT led to inconsistent findings (Stoltz & Dekovic, 2015). Considering previous research on a preventive PMT with face-to-face sessions, the number of sessions attended was negatively associated with parent-reported negative parenting and positive with positive parenting (at posttest, self-reported and observed by a clinician) (Weeland et al., 2017). However, no associations were found for the number of sessions attended and caregiver-reported and observed child externalizing behaviours at posttest (Weeland et al., 2017).

As the need for an improved supply is high and research has generally yielded divergent results, with some meta-analyses finding associations and others not, the aim of the second publication was to relate caregiver utilization to the effects of the intervention on child externalizing behaviour problems (Wähnke et al., in press 2024). As primary analyses, we conducted two path models in which the caregiver-reported and clinician-rated child ADHD symptoms were related to the caregiver's utilization measured by the number of logins (*frequency of usage*). To determine if the findings for the utilization-symptom associations could be replicated using a different measure of utilization, we conducted secondary analyses similar to the main analyses but used the percentage of completed materials (*intensity of usage*) as the utilization metric. We employed the number of logins for our primary analyses, as this is the measure most often used in previous research (Donkin et al., 2011) and, due to the automatic data tracking, a rather objective measure. This study adopted an exploratory approach to investigate the longitudinal and reciprocal associations between the utilization of WASH and the severity of child externalizing symptoms. Therefore, we did not formulate specific a-priori hypotheses for possible associations.

1.10 References Introduction

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2 Acceptance and Utilization of Web-Based Self-Help for Caregivers of Children With Externalizing Disorders

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RESEARCH

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Acceptance and utilization of web-based self-help for caregivers of children with externalizing disorders

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Abstract

Background Web-based self-help interventions for parents of children with ADHD and other externalizing disorders have been proven to be effective. In order to recommend individualized and optimized interventions, a better understanding of the acceptance and utilization of this innovative treatment approach is needed. Previous research has frequently employed subjective reports of utilization, but the validity of these studies may be limited.

Methods Data from the German WASH study were used. Participants ($n = 276$) were randomly assigned to the intervention condition (a) web-based self-help or (b) web-based self-help with optional telephone-based support calls. Data collection took place at baseline (T1) and 12 weeks later (T2). Utilization data were tracked using a log file generated for each participant at T2. Prediction models were calculated using CART (Classification and Regression Trees), a method known mostly from the field of machine learning.

Results Acceptance, of the intervention as defined in this paper was very high on objective (89.4% have taken up the intervention) and subjective measures (91.4% reported having used the intervention and 95.3% reported they would recommend the intervention to a friend). The average number of logins corresponded to recommendations. Predictors of acceptance and predictors of utilization were similar and included, e.g., child's externalizing symptoms, parental psychopathology, and above all additional telephone-based support by counselors.

Conclusions Through a detailed identification of acceptance and utilization, and the predictors thereof, we were able to gain a better understanding of the acceptance and utilization of web-assisted self-help for a parent management intervention in the treatment of children with ADHD and ODD. These findings can be used to recommend web-based interventions to particularly suitable families. It should be noted that some form of support is required for an intensive engagement with the content of the program.

Trial Registration The protocol of the study (German Clinical Trials Register DRKS00013456 conducted on January 3rd, 2018) was approved by the Ethics Committee of the University Hospital, Cologne.

Keywords Web-based self-help, Parent management training, Utilization, Acceptance, Externalizing symptoms, Children, Predictors

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Background

Parenting management training (PMT) has been shown to be effective in the treatment of children with ADHD and other externalizing disorders [1, 2]. Moreover, it has been found that behavioral PMT significantly reduces child denial behavior and noncompliance as well as parental stress [3]. Behavioral PMT aims to teach positive parenting skills in order to reduce common externalizing problems associated with ADHD symptoms in children. Generally speaking, behavioral PMT is based on cognitive behavioral strategies such as learning how to give effective commands and implementing contingency management strategies [4]. In view of the established evidence for the efficacy of (conventional) PMT, it forms part of the recommendations in current guidelines for ADHD, along with cognitive behavioral therapy and pharmacotherapy [5–7]. However, due to treatment supply gaps, which have been further compounded and magnified by the COVID-19 pandemic, there is an urgent need for evidence-based, low-cost, innovative, and easily accessible treatment approaches [8, 9].

Research has shown that innovative forms of treatment such as web- or telephone-based parental interventions can overcome some of the structural and social barriers (e.g. parental work commitments, fear of judgment) to accessing and attending parent management interventions in the treatment of child externalizing behavior problems [10, 11]. Indeed, several systematic reviews have reported that web-based PMTs are effective in reducing problem behavior, mostly with small to moderate effect sizes [12–16]. Furthermore, there is sufficient evidence that regular use and attendance is an essential prerequisite for the efficacy of any treatment, including web-based interventions [17].

In an online survey, some parents of school-aged children expressed a preference for parenting information on child mental health to be delivered via online programs rather than face-to-face training [18]. For a face-to-face PMT program, Breitenstein and coworkers found uptake rates (at least one session) of 76%, with mean attendance rates of 50% (out of 12 sessions) [19]. In later research, the same authors reported significantly higher module completion rates (85.4%) for an adapted tablet-based parent management program compared to attendance of sessions in face-to-face training [13]. In a randomized controlled trial comparing face-to-face and online behavioral parent training, DuPaul and colleagues found moderate acceptability for online PMT as rated by parents [20].

To date, however, operationalizations of the concept of acceptance of computerized interventions are heterogeneous, and measures of acceptance and utilization range from direct measures (e.g., self-report) [21] to objective measures (e.g., uptake time), with internet technologies

enabling user behavior in digital health interventions to be measured and tracked. Addressing the inconsistent designation and definition of the term acceptance, Rost and colleagues concluded that “it is not an instantaneous act”, but instead a process of “accepting, experiencing, and being satisfied.” [22]. Prior to the advent of objective data tracking, empirical studies used subjective ratings by users, meaning that previous research often lacks validity, potentially resulting in over- or under-reporting of the acceptance and utilization of interventions. Nevertheless, such measures are often used to complement objective data [23]. Objective measures of utilization focus on temporal aspects (e.g., frequency, duration) and depth dimensions (e.g., amount use of specific intervention content in percentage terms) [21, 24]. However, such a one-dimensional description has been criticized given that, for example, users may be logged in for a long period of time while making little progress. Therefore, researchers have called for a multidimensional description in terms of the so-called FITT categories (i.e., frequency, intensity, time, and type of engagement), which provide concrete dimensions associated with behavior-changing aspects of an intervention. The type of engagement can in turn be distinguished into “active” use (e.g., self-monitoring, writing) or “passive” use (e.g., viewing the intervention without interacting) [25].

A recent study by Tarver et al. (2021) identified several factors that may act as barriers to the utilization of web-based PMT, such as the presence of siblings during the intervention [26]. Unfortunately, most research findings do not allow for reliable inferences regarding the direct influence of individual variables (e.g., socioeconomic status) on the utilization of web-based interventions [16]. A meta-analysis revealed that older age, higher educational attainment, and female gender of the user were relevant factors influencing engagement with digital behavior change interventions (DBCIs) in adults [21]. DuPaul and colleagues recommend focusing on possible predictors in order to provide the optimal care tailored to the needs of individual families, as their research demonstrated similar effects of face-to-face and online PMT in terms of acceptability and engagement [20]. However, in addition to sociodemographic and socioeconomic factors that may affect the utilization of web-based interventions, telephone-based support by therapists has been found to improve adherence and motivation [26]. Indeed, our own investigations showed that low-frequency telephone-based support by specialists can even improve the outcome effects of an intervention [27]. With the ultimate aim of improving the therapeutic supply situation for families with children with ADHD, the present study seeks to enhance the understanding of which families are likely to utilize web-assisted self-help.

Therefore, we investigated the acceptance and utilization of a so-called web-assisted self-help parent management training (WASH) program as part of the routine care of ADHD and other externalizing problems such as oppositional defiant disorder (ODD). A detailed and objective assessment of the parameters of utilization should provide more reliable insight into acceptance and utilization compared to previous studies that investigated self-reported usage or one-dimensional objective parameters [28]. Participants were randomized into two intervention groups (with and without additional telephone-assisted support) and compared regarding their acceptance and utilization of the online parent management training. We expected participants receiving additional telephone support to accept and use the intervention more often and intensively. In line with the literature and previous research on acceptance, we expected good overall acceptance regarding the WASH intervention. Based on previous findings and discussions, we took a multidimensional perspective to describe and analyze caregivers' utilization of the intervention, and expected to find, for example, that socioeconomic status, single parenthood, the option of personal telephone-assisted support, and the degree of parental psychopathological problems would be associated with and predictors of acceptance and utilization of WASH for parents.

Methods

Study design

This analysis is based on the intervention groups of a sample recruited by pediatricians and child and adolescent psychiatrists nationwide, within a 27-month period, as part of a study to evaluate the efficacy of a web-assisted self-help program (WASH; see Fig. 1) for caregivers of children with ADHD. The study protocol of the WASH study was published prior to recruitment [29]. Families of children aged 6 to 12 years with a (suspected) diagnosis of ADHD and/or ODD (T0) could be referred by their healthcare provider (HCP). For inclusion, children's externalizing (ADHD or ODD) symptoms had to be rated as clinically relevant at the first assessment time point (T1) by a member of the research team based on caregiver description using a semi-structured interview [30]. A diagnosis of mental retardation or autism spectrum disorder, as well as an indication for inpatient treatment, led to the exclusion of the family.

Eligible families were randomized to one of the two intervention conditions web-assisted self-help (WASH) or web-assisted self-help plus optional telephone support calls (WASH+SUPPORT), or to the control group (excluded from the present analyses). The WASH group was not actively contacted until post-assessment (T2), 12 weeks after T1. The WASH+SUPPORT group received an initial telephone call from a research team member

providing information (introduction to SUPPORT, arrangement of the first appointment). SUPPORT comprised up to six 20-minute telephone calls with a trained therapist under regular supervision, in which the therapist answered any questions and provided specific advice, mainly regarding the implementation of interventions recommended by the program into daily life.

Intervention

Web-assisted self-help for parents of children with ADHD (WASH)

WASH [31] is a self-help intervention for parents, which has been found to effectively reduce children's ADHD symptoms and oppositional behavior problems [27]. It is based on the Therapy Program for Parents of Children with Hyperkinetic and Oppositional Problem Behavior, the effectiveness of which has been demonstrated in several studies, both in the form of a face-to-face intervention and as a telephone-based self-help intervention [32–39]. The intervention's matrix design allows users to take an interest-based path through the program contents (see Fig. 1).

The program consists of four modules, each containing several components including (a) active tasks, i.e. text modules tailored to users' answers in previous interactive tasks assessing their individual situation (e.g. quality of their relationship with the child, ability to consistently express their family rules), and (b) passive tasks, i.e. videos and audio recordings to make the content easily accessible and to present options for solutions (see Table 1). Participants were provided with password-protected access to the online intervention. Upon logging in for the first time, they received user recommendations, including an overview and guidance for working through the program in a stepwise manner within the next 12 weeks. If a participant did not log in within the first five days after gaining access, they received an email reminder. Additionally, during the first two weeks of the intervention phase, all participants received three short reminder newsletters. Users could actively choose to receive further reminders.

Measures

Data were provided by the HCP (T0) and collected using (standardized) online questionnaires completed by the caregivers before the start of the intervention (T1) and three months after beginning the intervention (T2). Pre-intervention measures included: sociodemographic and socioeconomic status, utilization of further healthcare or child welfare services, special educational needs of the child or placement in a special school, symptoms of the child, psychopathology of the caregiver, and parenting style.

Module 1	Module 2	Module 3	Module 4
Solving behavioral problems	Positive relationship with your child	Self-care	ADHD – What is it?
temper tantrum homework clutter in the child's room			
Recognizing a problem: what's going wrong?	How good is your relationship?	Are you missing out?	Characteristics of children with ADHD
Analyzing the problem: vicious cycle	What do you like about your child?	Strengths & weaknesses	Additional problems
Setting rules	Time for fun & playing games	Planning everyday life	What causes ADHD?
Expressing effective requests	How to strengthen your child	Restore your energy	How do children develop?
Setting positive consequences		Special challenges in daily life	What can be helpful?
Setting natural negative consequences			Medication
Implementing reward plans			

Fig. 1 Structure of the WASH Parent Management Training (<http://www.adhs.aok.de>)

ADHD and ODD symptoms of the child were reported by the participating caregiver at T1 using the German Symptom Checklist for ADHD (SCL-ADHD) and ODD/CD (SCL-ODD) [30]. Both questionnaires consider the diagnostic criteria according to the DSM-5 and ICD-10. The SCL-ADHD assesses ADHD symptoms with eighteen items while the SCL-ODD assesses ODD symptoms with eight items. All items are rated on a four-point Likert scale ranging from 0 (not at all) to 3 (very much/particularly severe). Good internal consistency (Cronbach's alpha) has been shown for both instruments (overall ADHD symptoms: $\alpha=0.92$; ODD symptoms: $\alpha=0.90$).

Parental mental health was assessed at T1 using the German version of the Depression Anxiety Stress Scales (DASS) [40], a 42-item self-report questionnaire comprising three 14-item scales covering symptoms of depression, anxiety, and stress. Items are rated on a four-point Likert scale ranging from 0 (did not apply to me at all) to 3 (applied to me very much, or most of the time), referring to the past week. For the present analysis, item mean scores were calculated for the three scales, demonstrating good to very good internal consistencies at T1 (Cronbach's $\alpha=0.95$, subscales Cronbach's $\alpha=0.86$ to 0.90).

The German Questionnaire for Positive and Negative Parenting Behavior (PNPQ) is a self-report measure assessing functional and dysfunctional parenting behavior practices [41]. Parents rate each of the 38 items (21

items on positive parenting behavior and 17 items on negative parenting behavior) on a four-point Likert scale ranging from 1 (never) to 4 (very often/most of the time). In the standardized questionnaire, positive parenting behavior is defined as that which promotes beneficial parent-child interaction, while negative parenting behavior is defined as inconsistent, impulsive, rigid parenting strategies. In the present sample, both scales showed satisfactory consistency (Cronbach's $\alpha_{\text{positive}}=0.86$; Cronbach's $\alpha_{\text{negative}}=0.70$).

Each participant generated log files by using the program from T1 to T2. These files were imported into SPSS for descriptive and inferential statistical analyses and into R for prediction analyses [42, 43]. Numerical aspects of utilization of the program (e.g., number of logins, duration of use, number of completed videos, number of completed tasks) for the 12-week intervention phase were extracted from the system at T2 for each user. Based on this, variables such as intervention uptake rates and uptake time, as well as frequency and process of use (in %) were aggregated. We defined *intensity of use* as the percentage of tasks/videos completed in the intervention in relation to the total number of tasks and videos within a module/ situation (see Table 1). Reliability analyses for the calculated *intensity of use* scale revealed an acceptable internal consistency ($\alpha=0.78$). *Acceptance* was defined according to the literature as follows: At T2, caregivers were asked (a) whether they had used the program

Table 1 Number of Tasks, Videos, and Audios in WASH per Module, Situation, and Total

Module / Situation	Content	Inter-active Tasks	Videos/ Audios	Total (100%)
Module 1	Solving behavioural problems	288	46	334
Situation 1	Temper tantrum	50	8	58
Situation 2	Homework	42	7	49
Situation 3	Chaos in the child's room	34	6	40
Situation 4	Constant interruption	43	6	49
Situation 5	Media consumption	34	6	39
Situation 6	Sibling conflicts	43	6	49
Situation 7	Restlessness at meals	42	7	49
Module 2	Positive Relationship with your child	10	8	18
Module 3	Self-Care	21	5	26
Module 4	ADHD-What is it?	7	(4)	11
Module 1–4	Total Utilization	326	59	385

and (b) whether they would recommend the program to a friend [22, 44]. In addition to these subjective measures, we recorded the following objective measures of acceptance: the *uptake rate* (i.e., at least one login) and the *return rate* (i.e., a minimum of two logins). The *uptake time* refers to the number of days between a participant

receiving the login information and their first login. As the original variable measuring the *duration of use* (time in minutes) was subject to a systematic recording error (no automatic logout if the page continued to run in the background as an open tab, e.g., on a mobile device), the variable of duration of use was checked for outlier values. Therefore 9% of the training participants no longer had a valid value for the variable *duration of use* and were not included in the analyses of this dimension.

Sample

The following analyses were conducted in the subsample of $N=276$ (T1) caregivers in the two intervention conditions WASH ($n=135$) and WASH+SUPPORT ($n=141$) who were recruited as part of the WASH study (see Fig. 2). Participants of the original WASH sample who were randomized to the control condition ($n=147$) and cases with missing values at T1 ($n=8$) were excluded from the following analysis. Dropout at the T2 measurement “Acceptance self-report” resulted in a reduced sample for the subjective self-report ($n=170$) on utilization and rating of the intervention. For the present analyses, this had no impact on the following prediction of utilization, which is based on objective measurement (highlighted in grey in Fig. 2).

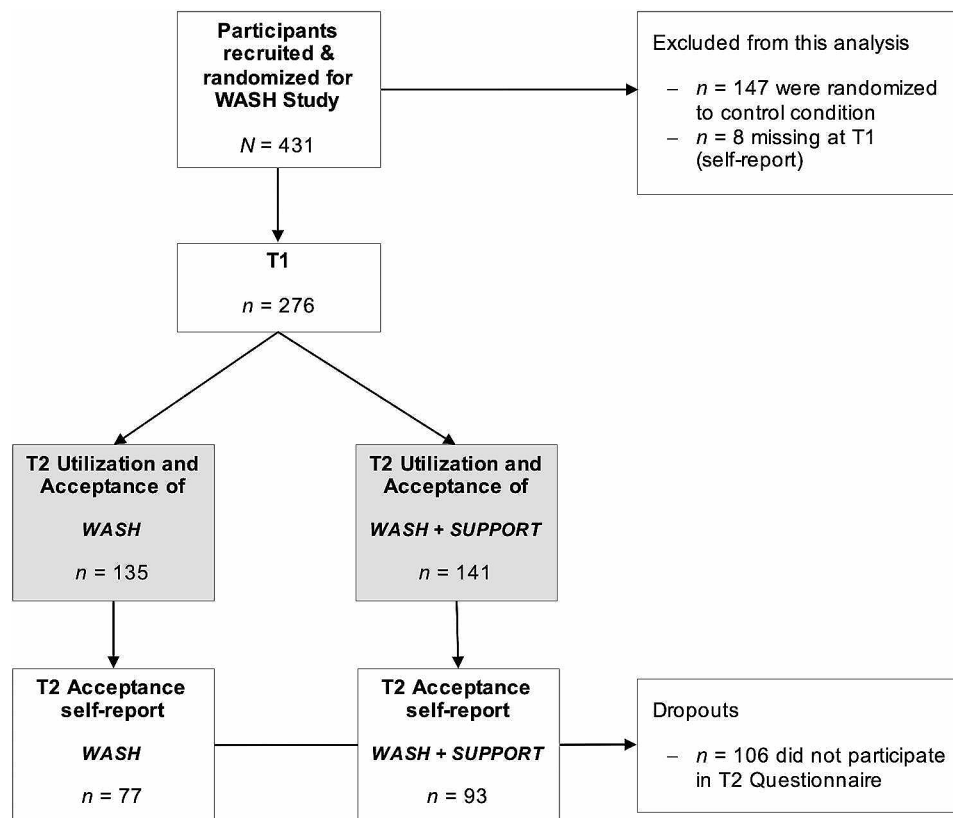


Fig. 2 CONSORT participant flow

Statistical methods

To gain further insight into utilization-related factors, the present article is based on exploratory, inductive data analyses using *IBM SPSS Version 28.0* [43]. For independent group comparisons of the central tendencies, methods appropriate to the scale level were used (binomial test, Mann-Whitney U test, t-test). To obtain a broad overview of multiple factors predicting the utilization of web-assisted self-help for parents, a tree analysis using the CART (Classification and Regression Trees) method was conducted [45, 46] within the statistical software *R version 4.2.1* [47]. The method of decision tree analysis has recently become popular in medical research [48]. CART visualizes complex data structures based on decision tree models, allowing for easy interpretation. It enables the splitting of various (unselected beforehand) categorical and continuous dependent variables, representing classification rules based on decision paths (“if-then”). In our analyses, the splitting procedure was continued until the following, predefined criteria were met: a minimum number of cases per final tree leaf (min-bucket)=5, the minimum number of cases allowing for a split (minsplit)=15, the maximum number of trials to find a valid split (cross-validation)=5. To find the best model, the largest possible tree was grown first and then pruned [48]. Hence, we focused on the predictive and non-predictive information provided by a model rather than exclusively on its performance. This allows results to be implemented and used in practice and not only in the research context. The receiver operating characteristic (ROC) analysis was conducted to evaluate the performance of the reported prediction model using the Area Under the Curve (AUC) value with regard to the 95% confidence interval (CI). The AUC indicates the accuracy, i.e. overall success rate [49]. The value defines the proportion of correctly classified records, resulting in the probability with which the prediction of acceptance or utilization can be correctly made. Generally, AUCs from 0.7 to 0.8 are rated as acceptable and AUCs from 0.8 to 0.9 as excellent [50]. In addition, to balance the method, we compared the CART analysis with hierarchical backward stepwise regression [51]. Continuous predictor variables (including number of support calls, number of sessions) were rounded to whole numbers. We conducted tree analyses with the outcome variables (1) *uptake rate* and (2) *return rate* to explore the previously described issues in research on acceptance. To predict utilization, we defined two outcome variables for conducting the tree analyses: (1) *number of logins* (n, temporal dimension as in frequency of use) and (2) *utilization* (% , depth dimension as in intensity of use). The prediction analyses were conducted using the data of the 276 caregivers who participated in the pre-assessment and were given access to the intervention (see Fig. 2).

Results

Descriptive characteristics of the sample

Table 2 summarizes the sample characteristics. Caregivers were mostly female (92%) and biological parents of the child (94.9%), and their mean age lay at 41.9 years (± 5.95). The majority were born in Germany (91.7%), with German as the main spoken language in the household (98.2%). 87.3% reported two children per household, which is also the numerically largest group in Germany as a whole (“one or two children”: 86.54%) [52]. In 90.9% of cases, caregivers reported that the children had a room of their own at home. Caregivers reported an employment rate of 85.5%, which is comparable to the results of the German 2019 microcensus for German mothers aged 26–61 years (97.5% employment rate). The majority of caregivers reported a medium to high level of educational attainment (university entrance-level qualification: 59.8%, with university degree: 29.0%). In general, the results indicated a high socioeconomic status.

The average age of the 276 children was 9.3 years (± 1.7) and 81.9% were male. According to the information provided by the HCP at T0, 23.2% of the children had a “suspected diagnosis of AD(H)D” and 58.0% had a diagnosis of “ADHD (F90.0)”. The sex ratio in our ADHD-positive sample corresponds to the prevalence rates of ADHD in Germany, with boys being more frequently diagnosed than girls by a factor of 4.3 [53]. The majority of the children (77.2%) attended a regular school and had not received a special educational needs status. For the parent- and child-related variables, no statistical differences between the two intervention conditions were found at pre-assessment, meaning that the two conditions could be analyzed together. Previous (“never”, “only in the past”) or current (“until today”) usage of child- and parent-centered healthcare and youth welfare services was assessed with reference to the clinical guidelines (see Additional file 1). Caregiver experience with parent-centered interventions was rare (internet-based self-help interventions: 4.3%; self-help groups: 8.4%; parent management training by a specialist: 16%).

Description of user acceptance and utilization

The data flow of objective and subjective measures of acceptance is presented in Additional file 2. Subjectively assessed rates are reported based on participants remaining in the study until T2, which seems to provide the best estimate. Objectively measures are reported based on all participants included at T1. The uptake rate (i.e., at least one login) in our sample lay at 85.9%. The uptake rate in the WASH+SUPPORT condition (89.4%) was significantly higher (binomial test: $p=.013$) than that in the non-supported WASH condition (82.2%). The return rate (i.e., at least two logins) for the whole sample was 71.4%, and the two conditions differed significantly (binomial

Table 2 Sample characteristics of caregiver and child at T0 & T1 (n = 276)

	Total n = 276			WASH n = 135			WASH + SUPPORT n = 141			Statistics			
	M	SD	Min	Max	M	SD	Min	Max	M	SD	Min	Max	P
Healthcare Supply													
Profession (paediatrician)	163 (59.1%)				84 (62.2%)				79 (56.0%)				0.078 ⁷
Supply situation (urban)	230 (83.3%)				114 (84.4%)				116 (82.3%)				0.275 ⁷
Age (years) ¹	41.93	5.95	26.61	61.54	41.70	6.03	26.61	61.54	42.15	5.90	28.61	58.78	0.530 ⁸
Sex (female)	254 (92.0%)				124 (91.9%)				130 (92.2%)				0.527 ⁹
Partnership/ married (yes)	244 (88.4%)				119 (88.1%)				125 (88.7%)				0.484 ⁹
Highest education													0.181 ⁷
Low ²	38 (13.8%)				17 (12.6%)				21 (14.9%)				
Medium ³	131 (47.5%)				60 (44.4%)				71 (50.4%)				
High ⁴	107 (38.8%)				58 (43.0%)				49 (34.8%)				
Currently employed (yes)	122 (85.5%)				114 (84.4%)				122 (86.5%)				0.287 ⁹
Parenting ⁵													
PNPQ – positive parenting	3.02	0.33	2.19	3.81	3.02	0.33	2.19	3.71	3.02	0.32	2.29	3.81	0.985 ⁸
PNPQ – negative parenting	1.94	0.29	1.24	2.82	1.93	0.29	1.29	2.71	1.94	0.28	1.24	2.82	0.792 ⁸
Psychopathology ⁶													
DASS – total	0.61	0.40	0	2.26	0.60	0.37	0	1.83	0.62	0.43	0	2.26	0.650 ⁸
Child													
Age (years)	9.34	1.73	6.0	12.97	9.31	1.73	6.00	12.97	9.34	1.74	6.00	12.92	0.720 ⁸
Sex (male)	226 (81.9%)				109 (80.7%)				117 (83.0%)				0.286 ⁹
Number of siblings	1.05	0.83	0	5	1.02	0.81	0	4	1.09	0.85	0	5	0.529 ⁸
Externalizing symptoms													
SCL-ADHD													
Total value	1.77	0.52	0.55	3.00	1.83	0.47	0.56	3.00	1.72	0.56	0.55	2.95	0.095 ⁸
Inattention ⁶	1.98	0.54	0.22	3.00	2.03	0.48	0.22	3.00	1.94	0.58	0.44	3.00	0.202 ⁸
Hyperactivity/ impulsivity ⁶	1.60	0.67	0	3.00	1.66	0.64	0	3.00	1.54	0.68	0	2.91	0.128 ⁸
Skills & reflectivity	0.69	0.49	0	2.67	0.64	0.45	0	2.67	0.74	0.52	0	2.67	0.091 ⁸
Impairment & burden	1.75	0.63	0.25	3.00	1.80	0.63	0.40	3.00	1.69	0.63	0.25	3.00	0.134 ⁸
SCL-ODD													
Oppositional behavior ⁶	1.50	0.69	0	3.00	1.54	0.66	0.13	3.00	1.46	0.72	0	2.75	0.361 ⁸
Prosocial behavior	0.73	0.52	0	2.91	0.74	0.55	0.50	2.83	0.72	0.49	0.42	3.00	0.728 ⁸
Impairment & burden	0.86	0.46	0	2.29	1.45	0.72	0	3.00	1.35	0.74	0	3.00	0.243 ⁸

Note n = sample size, M = mean, SD = standard deviation, Min = minimum, Max = maximum, p = probability of error, PNPQ = Positive and Negative Parenting Questionnaire, DASS = Depression, Anxiety and Stress Scales, SCL-ADHD = Caregiver Self-Checklist of Child's Attention-deficit/Hyperactivity Symptoms, SCL-ODD = Caregiver Self-Checklist of Child's Oppositional Defiant Disorder Symptoms

¹Reduced n due to one missing value at T0. ² low = no school-leaving qualification, primary school certificate or special needs school certificate, ³ medium = secondary school-leaving certificate, ⁴ high = high school graduation, technical college entrance qualification, university entry qualification, technical/master school, university (of applied sciences) degree; ⁵ High key value indicates high agreement with positive/ negative parenting style. ⁶ Items rated 0 'not at all'; 1 'a little applicable'; 2 'largely applicable'; and 3 'especially applicable'. A high key value (mean item score) indicates high symptomatology. ⁷ Intergroup differences were tested using Mann-Whitney U test. ⁸ Intergroup differences were tested using t-test for independent samples. ⁹ Intergroup differences were tested using binomial test

test: $p \leq .001$), with more returns for WASH+SUPPORT (80.1%) than for WASH only (62.2%). At post-assessment (T2, $n=187$), caregiver self-reported (subjective measures) acceptance was high, with 91.4% ($n=171$) reported having used the program (at least once or regularly), of which 95.3% ($n=163$) would rather recommend the program to a friend. Again, there were significant differences between the two conditions, with WASH+SUPPORT more frequently logging into the intervention at least once (binomial test: $p=.003$) and being more likely to recommend the intervention to a friend (binomial test: $p=.005$).

Caregivers' utilization can be described in terms of *frequency*, *intensity*, and *further dimensions*; intergroup differences are shown in Table 3. The majority of participants (75.9%, $n=167$) logged in for the first time within eight days after the start of the intervention. The average *response time* (*uptake time*) was 8.71 days, but showed a high variance, resulting in no significant differences between the two conditions. On average, five logins (*number of logins*) were generated, with a total usage *duration* of 4.84 h. Users processed an average of 31.17% ($\pm 26.18\%$) of the content across all modules, with 5% ($n=15$) of the caregivers completing more than 75% of the content. Participants in the supported condition used the program significantly more often ($t(273.79) = -3.583$; $p \leq .001$), more intensively ($t(274) = -2.766$; $p = .006$), and for a longer time ($t(196.57) = -3.271$; $p = .001$) compared to those in the pure self-help condition. Overall, between 74% and 85% of the caregivers viewed (i.e. had seen any of the content from a module) the four modules (see Additional file 3). Those who viewed any of the content from module 1 (85.9%) had also viewed modules 2 and 3. Although the psychoeducation module (module 4) was viewed by slightly fewer caregivers (74%), it was processed the most (53% on average). We found statistically significant correlations between the utilization variables (global as well as detailed) and other described usage parameters, lying in the expected positive direction (see Additional file 4). The strongest (positive) correlation was found between *intensity* (%) and *frequency of use* ($r = .73$, $p \leq .001$). However, other correlations were weak to moderate. The corrected time variable "duration" (variable corrected for outliers as described above), as with the correlations for all other variables, showed moderate significant correlations with the other usage parameters ($r_{intensity} = 0.39$, $p \leq .001$; $r_{frequency} = 0.43$, $p \leq .001$) and can thus be regarded as a reliable measure and description of temporal utilization. Moreover, significant correlations emerged between active (individual rating or text) and passive (video or audio) utilization for all modules (see Additional file 5) and in total ($r = .72$, $p \leq .001$). However, mean comparisons indicate more usage (intensity) of passive than active steps.

Prediction analyses

For the prediction analyses, significant main decision paths are reported. A full overview of all decision paths (for all decision trees conducted in this analysis) can be retrieved from Additional file 6.

Acceptance

To predict initial parental *acceptance* of the intervention, we conducted a CART analysis on the variable *uptake*, with an acceptable AUC of 0.74 (CI: 0.65–0.83) for the biggest tree grown (see Fig. 3). The best primary predictor of uptake was positive parenting skills measured at T1. Overall, it was observed that initial uptake was more likely for 65.2% ($n=180$) of the sample who reported a positive parenting (PNPQ) score below 3.6, an ADHD symptom score below 2.7 (range 0–3), a score below 1.8 on the FBB-ADHS subscale assessing competent behavior of endurance, attention, and reflectivity ('ADHD Skills & Reflectivity', range 0–3), and with a caregiver age ≥ 38 years. However, approximately 5% of these cases still did not take up the intervention. Relatively speaking, initial uptake was also more likely for a further 18% of the sample with a caregiver age below 38 years, a child age below 11 years, and a score of 0.25 or higher on the SCL-ADHD subscale assessing competent behavior of endurance, attention, and reflectivity.

The starting point of CART for the dependent variable *return rate*, as another index of acceptance, is the number of support calls, indicating that this primary split is the best predictor of returning to the intervention after the initial uptake (see Fig. 4). For 33% of the sample, the results indicate that with two or more support calls and a caregiver-reported ADHD symptom score above 1.3, 30.4% returned to the intervention and only 2.5% did not return. A stronger tendency towards *not returning* to the intervention was predicted for 4.7% of our sample with less than two support calls, a very high caregiver-reported ADHD score (over 2.4), and very positive parenting (≥ 3). In this decision path, only $n=1$ caregiver returned to the intervention. Further factors such as the child's oppositional symptoms and prosocial behavior as well as parental psychopathology (depression, stress, anxiety) added to the prediction of parental return to WASH. However, other factors, such as supply situation, type of intervention (WASH or WASH+SUPPORT), and sociodemographic and socioeconomic variables of the caregiver or child were not significantly related to whether caregivers returned to the intervention after an initial login. The result, with an excellent AUC of 0.84 (CI: 0.78–0.89), correctly predicts 84% of the records regarding whether or not users returned.

Table 3 Utilization parameters and intergroup differences

Parameters of Utilization	Total			WASH			WASH+SUPPORT			Statistics								
	n	M	SD	Min	Max	n	M	SD	Min	Max	n	M	SD	Min	Max	t	df	p [†]
Frequency																		
Number of logins (n)	276	5.00	4.38	0	18	135	4.05	4.25	0	17	141	5.90	4.32	0	18	-3.583	273.79	<0.001
Intensity																		
Process (%)	276	31.88	26.08	0	96.70	135	26.97	25.58	0	96.70	141	36.58	25.78	0	88.07	-2.766	274	0.006
Further Parameters																		
Uptake time (days)	237	8.71	14.63	0	82	111	8.62	14.67	0	82	126	8.79	14.65	0	79	-0.086	235	0.930
Duration (h)	254	4.84	8.20	0	53.87	126	3.18	5.42	0	31.95	128	6.48	9.98	0	53.87	-3.271	196.57	0.001
Support calls (n)	-	-	-	-	-	-	-	-	-	-	143	4.62	2.09	0	6	-	-	-

Note[†] For group differences, a t-test for independent groups was calculated

Prediction of frequency and intensity of use

The *frequency of use* (i.e., number of logins; see Fig. 5) was predicted with an excellent accuracy of AUC=0.80 (CI: 0.75–0.85). The branching nodes show the mean number of logins (first line in each node) and the absolute and relative number of caregivers ending up in the branch (second line in each node). The mean number of logins across all parents (n=276) was 5. The decision rules can be divided into decision paths that lead to very frequent usage (more than 10 logins) and very little usage (maximum of two logins). Besides the number of support calls, the symptoms of the child (ADHD and ODD symptoms), and parental psychopathology, it emerged that sociodemographic variables of the child (gender) and caregiver (age), as well as socioeconomic variables (e.g., afternoon/evening childcare, marriage status) and parenting skills (positive parenting) were meaningful predictors of caregivers’ number of logins to the intervention. Above all, the starting point of the tree is the number of support calls, which affected parental utilization in terms of frequency. However, even when less than two support calls were realized, some further factors positively affected the frequency of use: An above-average number of logins (e.g. eleven logins) occurred if caregivers reported a score below 2.0 for oppositional defiant disorder of the child (ODD OPP), being married or in a partnership, availability of afternoon care, caregiver’s age ≥ 39 years, and a score over 2.0 for ADHD symptoms. Other factors, such as the referring HCP (psychiatrist or pediatrician), as well as the type of intervention (WASH or WASH+SUPPORT), educational level, employment situation, and special educational needs, were not significantly related to the frequency of use.

The decision tree for the *intensity of use* (percentage of completed tasks/videos) was also built with an excellent AUC of 0.80 (CI: 0.75–0.85). Figure 6 displays the mean percentage of completed tasks/videos (first number in each node) and the absolute and relative number of caregivers who achieved this completion rate (second line in each node). Across all participating caregivers, the mean percentage of completed tasks/videos was 32%. The best predictor was the number of support calls received. The decision tree splits the sample into two branches: The caregivers who used all six support calls (the maximum we offered) completed more tasks/videos than those who used fewer support calls. However, some conditions resulted in a higher rate of completed tasks/videos even for caregivers using fewer than six support calls (e.g., caregiver age ≥ 47 years). In addition to the referral context (referred by pediatrician or psychiatrist), sociodemographic (age) and socioeconomic (education) variables of the caregiver, symptoms, and impairment of the child (ADHD and ODD), and parenting skills (positive parenting) added to the prediction of caregivers’ completion

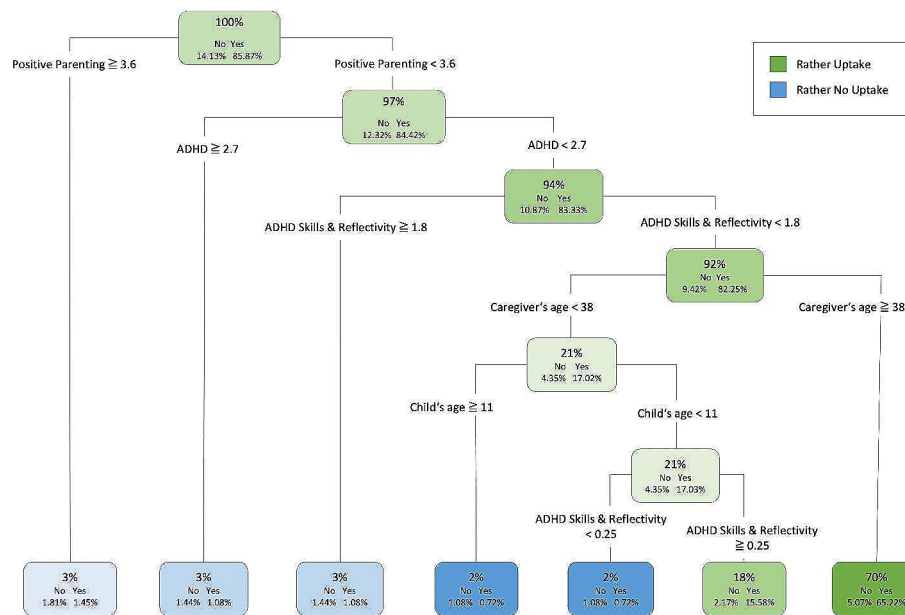


Fig. 3 Decision tree predicting initial uptake of the WASH intervention. *Notes.* For each node, the first line shows the percentage of our sample ($n=276$) that ends up in the leaf, followed by the information whether the intervention was initially taken up (yes) or not (no) and the third line indicating the respective rate in relation to the sample. The color of leaf indicates that the majority of cases in this leaf (paths) has taken up (green) or has not taken up (blue); ADHD = ADHD Overall Symptomatology

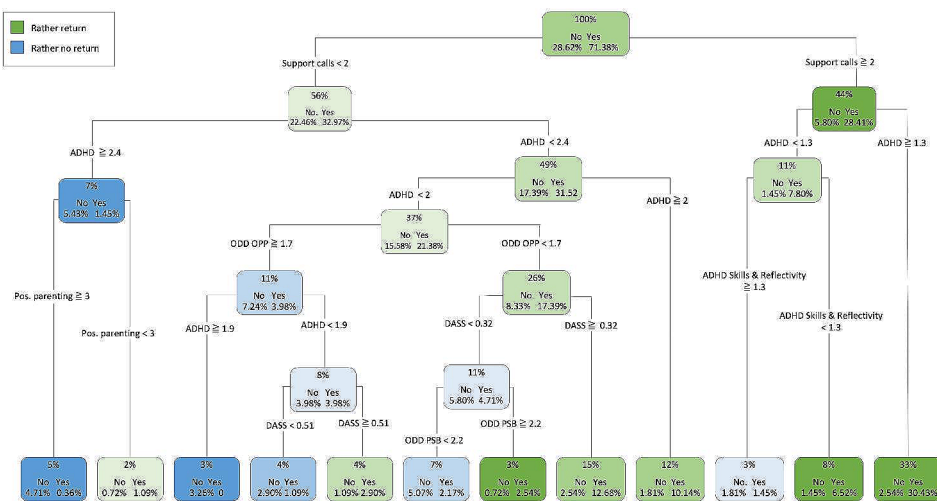


Fig. 4 Decision tree predicting a return to the intervention after initial login. *Notes.* For each node, the first line shows the percentage of our sample ($n=276$) that ends up in the leaf, followed by the information whether caregivers returned to the intervention after initial login (yes) or not (no) and the third line indicating that the respective rate is in relation to the sample. The color of leaf indicates the majority of cases in this leaf (paths) returned (green) or did not return (blue); ADHD = ADHD Overall Symptomatology, ODD OPP = Oppositional Defiant Disorder, Oppositional Subscale; ODD PSB = Oppositional Defiant Disorder, Prosocial Behavior; DASS = Parental Psychopathology (Depression, Anxiety, Stress), Pos. Parenting = Positive Scale

rate of tasks/videos. However, the type of intervention (WASH or WASH+SUPPORT), employment situation, and other socioeconomic factors (e.g., single-parent status, number of people per household, afternoon childcare) or special educational needs, were not significantly related to the intensity of use.

For all analyses, the comparison using alternative backward stepwise regression analyses resulted in a better performance of the CART algorithm (AUC values).

Discussion

To the best of our knowledge, the present study is the first to systematically investigate and describe factors of parental acceptance and utilization in the context

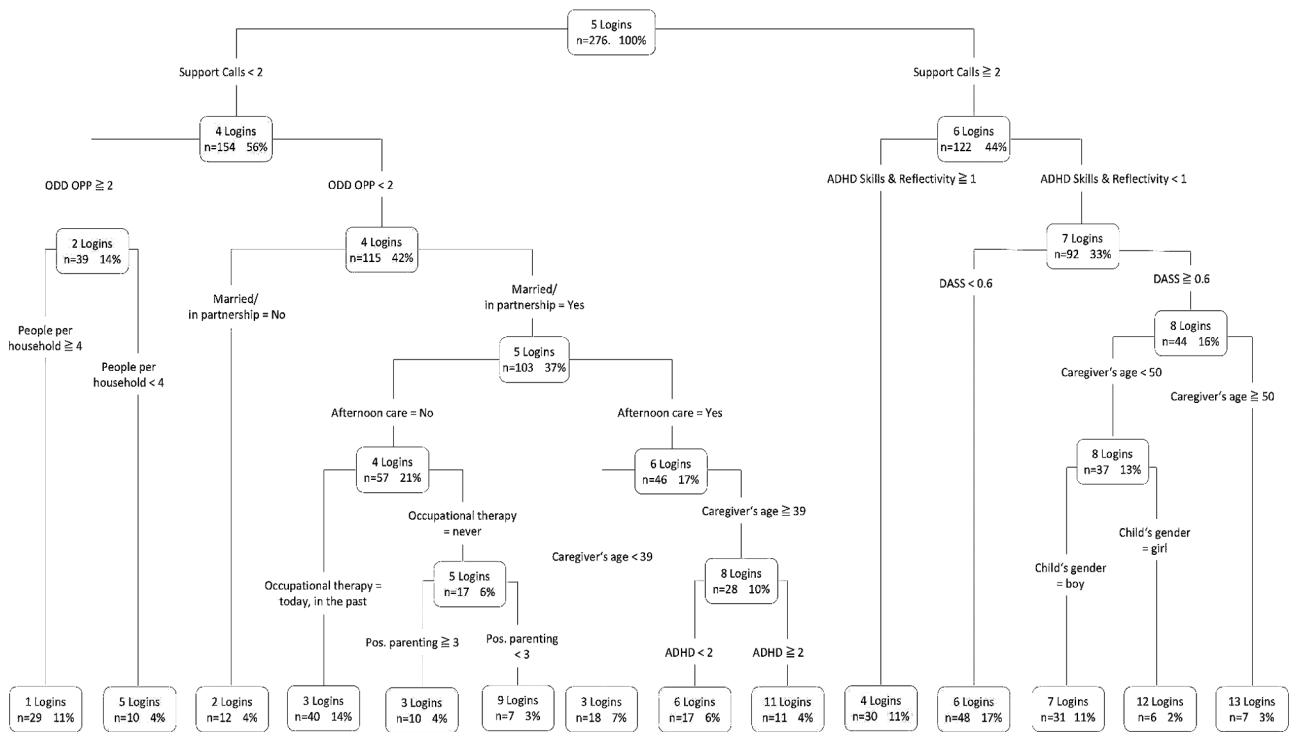


Fig. 5 Decision tree predicting the frequency of use (number of logins, n). *Notes.* For each node, the first line shows the mean numbers of logins. In the second line, the number of cases and percentage of the complete sample (n = 276) that ends up in the branch is displayed. ADHD = ADHD Overall Symptomatology; ODD OPP = Oppositional Defiant Disorder, Oppositional Subscale; DASS = Parental Psychopathology (Depression, Anxiety, Stress), Pos. Parenting = PNPQ, Positive Scale

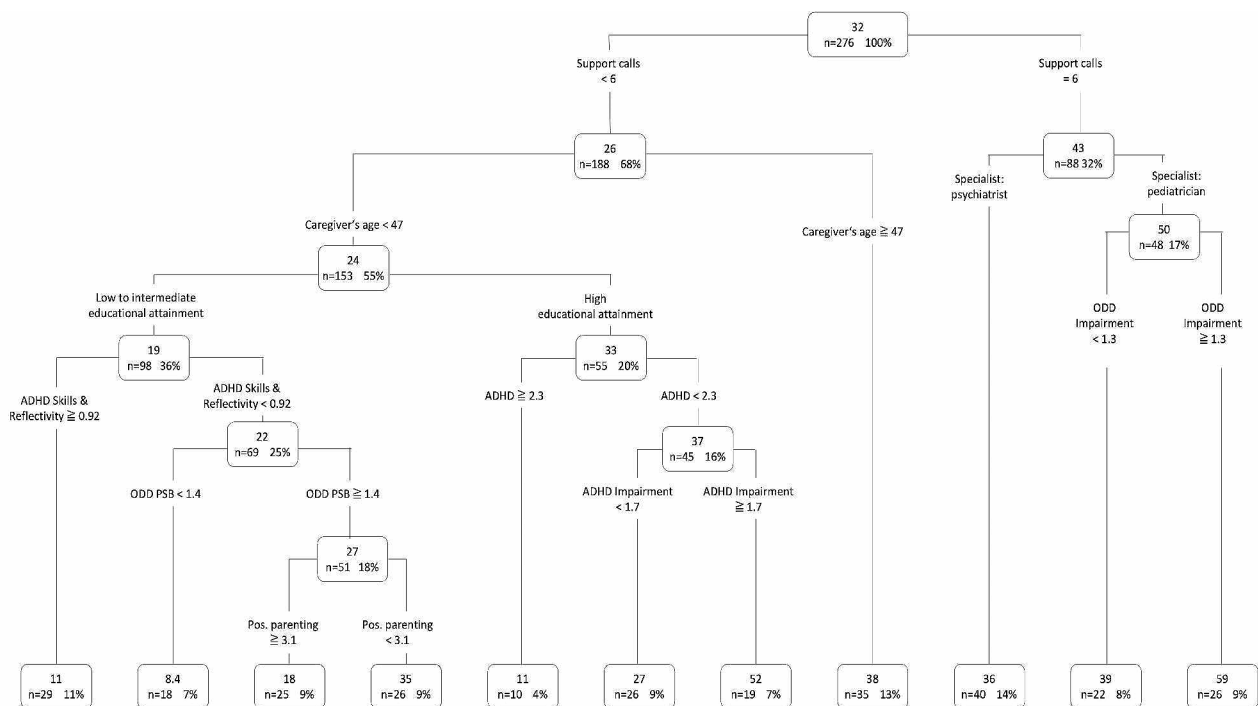


Fig. 6 Decision tree predicting the intensity of use (completed tasks/ videos, %). *Notes.* For each node, the first line shows the mean intensity of utilization (%). In the second line, the number of cases and percentage of the complete sample (n = 276) that ends up in the branch, is displayed. ADHD = ADHD Overall Symptomatology; ODD PSB = Oppositional Defiant Disorder, Prosocial Behavior; Pos. Parenting = PNPQ, Positive Scale

of web-assisted self-help interventions for parents of children with ADHD. Our results demonstrate that (1) acceptance of WASH is high, both according to objectively collected data and self-report, and (2) the additional support calls as well as child- and caregiver-related psychopathology and positive parenting are the main predictors of acceptance and utilization. Unfortunately, like previous research, we were not able to include the underserved target group of caregivers in less served regions, with less educational background and families with less access to evidence based ADHD treatment. Our sample has a rather high socioeconomic status, which should be considered in the following discussion and especially regarding the generalizability of the results.

Our data reveal that WASH is well accepted for both active intervention groups (with and without telephone support), as documented both by objective measures (uptake rate and return rate: from 70 to 85%) and subjective measures (self-report: 90–95%). The uptake rate was comparable to the rate of 76.4% (i.e., attending at least one session) reported in the Chicago Parent Program, a face-to-face parent training program for families from low-income urban communities [19]. Our results fit well with other web-based treatments, such as the ezParent program to prevent child behavior problems in preschoolers, in which only a third of the participants who signed up, from a low-income population, failed to attend any sessions [13]. In fact, in the present study, only 15% of participants did not log in to the WASH program at all, indicating that acceptance in our sample was higher than that in the ezParent program. These good acceptance rates may be attributable to the advantages of online interventions: WASH is available 24/7 and can be easily accessed through a smartphone, tablet, or laptop and from anywhere with internet access. Previous analyses have likewise indicated a preference for online treatment for caregivers of children with anxiety and depression [18]. Flexibility in parent training, as a key element of acceptance, was also reported by Tarver and colleagues in qualitative analyses of an ADHD self-help program [54]. It has to be taken into account, that the ezParent program is an intervention addressing families of cultural diversity and with particular needs. Therefore, comparisons of the results should be interpreted with caution. Regarding the initial login (uptake), using CART, we were able to correctly predict acceptance for about 74% of cases, which is considered acceptable [50]. The prediction of the return rate showed an even better performance, with 84% correct predictions. It has been expected that online interventions such as WASH may primarily be accessed by those in less well-served supply situations such as rural areas. However, our results did not support this assumption: For both initial uptake and return, ADHD/ODD symptoms of the child, caregiver

psychopathology (depression, anxiety, and stress), and parenting style were important predictors. The most important predictor of return was the number of support calls, with a higher number of calls increasing the probability of return, in line with earlier research findings [22]. For a small group of caregivers, a very high level of self-reported positive parenting predicted non-acceptance in terms of no initial uptake. This predictor was also found in the decision paths for the return rates, indicating that caregivers with high levels of positive parenting (combined regarding return rate with less than two support calls and higher levels of ADHD) might not expect the program to be helpful for them. Moreover, even when they do accept the intervention, they tend to use it less in terms of frequency and intensity (cf. Figs. 5 and 6), supporting the hypothesis that the intervention is not very promising in this population.

Overall, research on acceptance has yielded divergent findings to date, which might be explained by the very different operationalizations of the term acceptance itself. Indeed, many research groups interpret it more in the sense of satisfaction with an intervention, rendering it difficult to compare the research findings on (online) PMT acceptance. For instance, a recent study examining behavioral parent training (BPT) with additional child-therapist support reported high acceptance based on caregivers' satisfaction (e.g. "The length of the treatment program met my expectations and the needs of my family"), which caregivers self-rated with mean scores between 3.8 and 4.9 on a five-point Likert scale [55]. Generally speaking, there does not yet appear to be any agreed-upon best practice when it comes to evaluating patient/ user acceptance in the context of internet/mobile-based health interventions [56]. Future research should assess acceptance based on theoretical models such as the well-established *Unified Theory of Acceptance and Use of Technology* [57], which is often reported as both theory-based and as empirically proven for the evaluation of acceptance (in technology) and focuses on aspects such as attitudes towards the technology, self-efficacy (health- and technology-related), and perceived barriers (such as security barriers).

Regarding the utilization of WASH, an average frequency of five logins (out of six recommended sessions) was found, which can be described as an 83.3% attendance rate. A study analyzing a comparable training program for parents of children with ADHD, provided either face-to-face or online, reported a mean of 80% session attendance/ completion, which the authors described as "high", and a t-test indicated no significant group differences between the online and the face-to-face condition [20]. On the other hand, the utilization in terms of completed tasks/videos in the present study is rather low (average of 31.7%). However, participants of WASH were

free to choose how they engaged with the program (in terms of logins and which tasks/videos they completed) and a 100% completion rate was not expected due to the modular architecture of the website, allowing parents to only use the tasks/videos they perceived as relevant to them. A systematic review on the use of technology and digital delivery methods of parent management training reported a content completion rate ranging from 41.7 to 99.2% [58].

The decision tree models for utilization of WASH were able to correctly predict for 80% how often (number of logins) and how intensively (number of completed tasks/videos) the intervention was used. In these analyses, telephone-based support was the most important predictive variable for both utilization parameters. The influence of the number of support calls is more relevant than simply the offer of support (in one intervention group), as this variable had the same likelihood of becoming a predictor in the CART models but was not included. These findings are in line with previous research in smaller samples [26]. With comparably little support (at least two support calls), the frequency of use increased significantly, whereas more intensive support (six support calls) led to an improvement in intensity of use. However, when discussing the relevance of this variable, it is necessary to consider further variables found in the decision paths. As the efficacy of a treatment depends on its actual use, and the mere attendance of an intervention does not ensure positive intervention outcomes [17, 59], additional therapeutic support is necessary to enhance utilization. Moreover, the results provide initial indications that a differentiated consideration of different utilization parameters certainly appears to be useful. Some variables are related to both parameters, as a higher age of the user of an online intervention was found to be associated with more frequent and more intensive utilization, thus confirming previous research findings of a meta-analysis on different interventions [21]. This seems surprising, and contradicts previous findings on caregivers' engagement in an internet-based health intervention (addressing a child's asthma), in which younger caregivers were found to log in more often [60].

Some variables, however, were exclusively relevant for either frequency or intensity of use: The presence of siblings in the same household is one factor that may prevent caregivers from using web-based interventions [54]. Using CART, we were able to show that the number of persons per household did affect caregivers' frequency of use (but not the intensity). It is important to note that expected factors such as being in a partnership/ married, and in line with previous research [26], availability of afternoon childcare, were predictively associated with more frequent logins, indicating that the intervention may have been more easily accessible for these families.

Exclusively (for the group of caregivers aged below 47 years), educational attainment was found to predict the intensity of use, insofar as caregivers with an especially high educational status used the intervention more.

Limitations

In terms of the findings mentioned above, it is important to note that the socioeconomic status of our sample was rather high, and the distribution of social parameters was skewed. In line with a previous study examining the role of parental engagement in a parenting program aimed at reducing risk factors of child depression and anxiety [61], we reached a mainly female, middle-aged, educationally highly qualified sample. This will primarily be an effect of the referral context (clinical utilization sample assigned by practicing psychiatrists or pediatricians), with the attractiveness of WASH for a selective sample only being a secondary factor in this regard.

The WASH study was able to make an important contribution to the empirical evaluation of factors of acceptability and utilization of web-assisted self-help. A strength of this analysis is the automatic data tracking, which enabled objective information on the acceptance and usage of the website. However, the tracking of utilization did not allow for any statements about the order of usage. Future studies should thus endeavor to record the utilization of modules in chronological order, in order not only to explain the general effectiveness but also to specify which contents of cognitive behavioral web-assisted self-help in ADHD parent management training are effective. Furthermore, we cannot guarantee that users actually engaged with the content rather than merely "clicking through" the intervention, as we did not conduct knowledge quizzes to prove caregivers' engagement.

Using the method of CART analysis, we were certainly able to follow an inductive approach and consider diverse predictive variables for the utilization of WASH and how they are related to each other, instead of investigating pre-selected predictors. A visual comparison of the two decision trees (frequency and intensity of use) reveals differences that might hint at multiple ideas for optimizing the intervention, but should not be over-interpreted due to the limited power of the sample.

In conclusion, it seems advisable to include different parameters, as there are clear differences between objective and subjective measurements, indicating that an under- or overestimation of acceptance (and potentially utilization as well) occurs when approaches exclusively use subjective measures. Moreover, we were not able to include information on why caregivers did not use the intervention due to missing data; causes of non-acceptance and factors of drop-out should be considered in future research. Further research is needed to assess the

efficacy of specific content and individual modules of the intervention and to further illuminate the important role of the support calls, especially regarding the intensity or frequency of support. The decision tree findings provide a useful contribution to the discussion of whether, and for whom, web-assisted self-help interventions can be helpful. Our results clearly underline the need for targeted recommendations oriented to specific criteria (e.g., with the help of decision tree findings), and highlight that support from a specialist who provides individual guidance throughout the intervention (main predictor) is especially important when attending web-based training, and renders the actual utilization of the intervention more likely.

Abbreviations

WASH	web-assisted self-help
SUPPORT	telephone-based support calls
RCT	randomized controlled trials
CART	Classification and Regression Trees
ADHD	Attention Deficit Hyperactivity Disorder (Symptomatology)
ODD	Oppositional Defiant Disorder
ODD OPP	Oppositional Defiant Disorder, Oppositional Scale (SCL-ODD)
ODD PSB	Oppositional Defiant Disorder, Prosocial Behavior Scale (SCL-PSB)
HCP	Healthcare Provider
PMT	Parent Management Training
FITT	Frequency, Intensity, Time, and Type of Engagement
DBCI	Digital Behavior Change Intervention
SPSS	Statistical Package for the Social Sciences
ROC	receiver operating characteristic
AUC	Area Under the Curve
CI	confidence interval
PNPQ	Positive and Negative Parenting Questionnaire
DASS	Depression, Anxiety, and Stress Scales
SCL-ADHD	Parent-rated German Symptom Checklists for ADHD
SCL-ODD	Parent-rated German Symptom Checklists for ODD
ICD-10	tenth edition of the International Statistical Classification of Diseases and Related Health Problems

Supplementary Information

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Supplementary Material 1: Child- and Parent-Related Healthcare Services Usage

Supplementary Material 2: Measures of acceptance

Supplementary Material 3: Content, Views and Intensity of Use (%) per Module

Supplementary Material 4: Correlation of Utilization Dimensions

Supplementary Material 5: Active and Passive Utilization

Supplementary Material 6: Decision Paths for CART Decision Trees

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Author contributions

MD and PL conceptualized the study. LW, MK, and JM collected and managed the data. MD, PL, AE, and MB supervised data management and analysis. LW analyzed and LW, MD, and PL interpreted the data. LW was the major contributor to writing the manuscript. PL and MD revised the manuscript critically. All authors read and approved the final manuscript.

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Data availability

The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

All procedures performed in the study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The present study was approved by the ethics committee of the University of Cologne. Informed consent was obtained from all individual participants included in the study. This article does not contain any studies with animals performed by any of the authors.

Consent for publication

Not applicable.

Competing interests

MD and JP receive royalties from publishing companies as authors of books and treatment manuals on parent training and assessment manuals. None of the other authors of this study reports any conflicts of interest.

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3 The Relationship Between Symptom Change and Use of a Web-Based Self-Help Intervention for Parents of Children With Externalizing Behavior Disorders: Exploratory Study

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Original Paper

The Relationship Between Symptom Change and Use of a Web-Based Self-Help Intervention for Parents of Children With Externalizing Behavior Disorders: Exploratory Study

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Abstract

Background: Web-based self-help (WASH) has been found to be effective in the treatment of child externalizing behavior disorders. However, research on the associations of caregivers' use of WASH and symptom changes of child externalizing behaviors is lacking.

Objective: This study examined the longitudinal and reciprocal associations between the use of WASH by caregivers of children with externalizing behavior disorders and their children's externalizing behavior symptoms.

Methods: Longitudinal data of 276 families from 2 intervention conditions of a randomized controlled trial (either unguided or supported by a therapist over the phone) were analyzed. Caregiver- and clinician-rated child externalizing behavior symptoms were assessed before (T1), in the middle (T2), and after the 6-month WASH intervention (T3). Additionally, 2 indicators of the caregivers' use of the WASH intervention were considered: number of log-ins (frequency) and the percentage of completed material (intensity). Associations of caregivers' use during early (T1-T2) and late (T2-T3) treatment with child externalizing behavior symptoms were analyzed using path analyses (structural equation modeling).

Results: Frequency and intensity of use were higher during the first 3 months than during the next 3 months of the intervention period. The number of log-ins at early treatment was significantly but weakly associated with caregiver-reported child externalizing behavior symptoms in the long term (T3). Moreover, caregiver-reported child externalizing severity at T2 predicted the number of log-ins in the late treatment. The results were not replicated when considering the percentage of completed material as a measure of use or when considering clinician ratings of child externalizing behavior symptoms.

Conclusions: The findings provide the first, albeit weak, evidence for longitudinal associations between caregivers' use of WASH and improvements in caregiver-rated child externalizing behavior symptoms. However, as the associations were rather weak and could not be replicated across different rater perspectives and operationalizations of use, further research is needed to better understand these relations and their interplay with other putative influence factors (eg, quality of the implementation of the interventions, changes in parenting behaviors).

Trial Registration: German Clinical Trials Register DRKS00013456; <https://www.drks.de/DRKS00013456>

International Registered Report Identifier (IRRID): RR2-10.1186/s12888-020-2481-0

KEYWORDS

web-based self-help; eHealth; parent management training; externalizing symptom; ADHD; attention-deficit hyperactivity disorder; self-help; use; child; children; parent; parents; management; management training; symptom; symptoms; caregiver; ODD; oppositional defiant disorder; treatment; web-based; caregivers; longitudinal data

Introduction

Parenting interventions have been shown to reduce oppositional defiant behavior problems in children [1,2]. Behavioral parent management training (PMT) has led to a reduced number of problematic situations of caregiver-child interactions reported by caregivers of children with attention-deficit hyperactivity disorder (ADHD) [3]. Although previous research has demonstrated both self-directed and face-to-face PMT to be effective in reducing child externalizing behavior disorders, outcome ratings of PMT vary across different assessors (eg, parents, clinicians, objective observations), with stronger evidence for PMT in caregiver reports [4,5]. Improvements have been reported by caregivers (completers) for conduct problems ($P=.001$) and hyperactivity symptoms ($P<.001$) [6]. Moreover, it remains unclear what drives symptom-related improvements: Although some studies indicate that parental attendance and engagement in face-to-face PMT are associated with greater symptom reduction for disruptive behavior, ADHD, and oppositional defiant disorder (ODD) symptoms [7], others indicate no differences in child behavior outcomes between mothers who complete versus mothers who drop out of PMT [6]. In a systematic review of preventive child mental health programs, higher levels of caregiver participation engagement (CPE) were associated with greater improvements in child internalizing and externalizing behavior symptoms [8]. Additionally, parental outcomes (eg, warm interactions, reduced physical punishment) seem to be associated with the quality of participation (rated by a therapist, eg, completion of between-session homework or the amount of participation in the group) rather than with mere attendance in PMT for conduct problems [9].

Web-based PMT is an easily accessible treatment alternative to face-to-face PMT, with proven effectiveness in the treatment of, for example, externalizing behavior disorders [10,11] and anxiety disorders [12]. There is evidence for the efficacy of web-based PMT regarding the reduction in conduct disorder and ADHD symptoms, with mostly small-to-moderate effect sizes [13-18]. However, self-help interventions often fail to keep caregivers engaged, rendering them difficult to complete [19,20]. In a 3-arm randomized controlled trial (RCT), we demonstrated that web-assisted self-help (WASH) combined with therapist telephone support (Döpfner et al, unpublished data, August 2024) is superior to routine clinical care, as well as WASH alone, in reducing clinician-rated child externalizing behavior symptoms [21]. Compared to face-to-face therapy and in line with other research on online interventions, our study revealed a relatively low intensity of use (average 35%), although the majority of participants (89.4%) logged in to the intervention at least once [22].

Considering self-directed interventions based on booklets for caregivers of children with externalizing behaviors (eg, booklets), parental adherence is associated with improved child externalizing behaviors [23]. Research on attrition and usage provides indications that more frequent users of eHealth report a decline in their perceived burden compared with an increased perceived burden reported by nonusers [24]. Regarding web-based PMT for caregivers of children with anxiety and depressive symptoms, parental engagement (defined as stronger orientation toward recommended use, ie, task completion) predicted (caregiver-rated) preventive parenting and lower impairment in the child's quality of life [25]. However, parental engagement did not predict changes in (caregiver- and child-reported) internalizing symptoms. By contrast, the self-reported frequency of practicing skills (during the "Cool Little Kids" online program) was associated with a greater decrease in child anxiety symptoms [12].

Conversely, children's severity of externalizing behaviors at baseline for the intervention on which this research is based has previously been found to be 1 of the predictors for the use of WASH [22]. There is evidence that parental perception of the severity of a child's symptoms is predictive of their help-seeking behaviors [26]. However, factors that are associated with parental engagement in children's mental health treatment have yielded divergent results, with some research indicating, for example, child mental health symptoms as a predictor for parental engagement and others not [8,27].

Clearly, the actual use of web-based interventions is a prerequisite for their efficacy. To date, there is no common sense of how the use of web-based interventions is conceptualized and operationalized, with measures ranging from direct measures (ie, self-report) to objective measures (ie, automatic data tracking of, eg, the number of log-ins) [28]. In the context of face-to-face treatment, the terms "engagement," "participation," and "adherence" are often used interchangeably; however, they include different therapy-related behaviors, from active participation during a session to practice implementation between sessions (eg, practically adapting parenting behaviors) [27]. In a systematic review, the most commonly reported measure for adherence is the number of log-ins to e-therapies [29]. However, a unidimensional operationalizing of the term's use has been criticized by researchers [30,31]; for example, one can often log in to the intervention (frequency), while making little progress (intensity) in the intervention. These parameters, though, seem to be associated with one another [22,27].

To the best of our knowledge, no study on web-based PMT for child externalizing behaviors has analyzed the relationships between parental use and changes in child externalizing behavior symptoms. Moreover, associations between the use of online interventions and symptom changes have rarely been examined in other child mental health conditions. The few available studies

differ regarding the type of intervention (eg, preventive program, booklet self-help, face-to-face group PMT), the target group (affected individuals, mostly adults, vs parents), operationalization of treatment use, outcome measures, and how outcome measures are assessed. In behavioral face-to-face PMT, research on the association between attendance and child externalizing symptom severity has yielded divergent results [8,27].

This study took an exploratory approach to examine the longitudinal and reciprocal associations between the use of WASH and child externalizing symptom severity using 3 subsequent assessment points of child externalizing behavior symptoms and in-between assessments of WASH uses. Although it might seem self-evident that the actual use of an intervention is a prerequisite for it to affect child externalizing behavior symptoms, previous research has yielded mixed findings in this regard [8,27]. Thus, we did not formulate specific a priori hypotheses for possible associations. Moreover, as a previous study using baseline data of the same data set as this study demonstrated the predictive value of baseline symptom severity for the subsequent use of WASH [22], we also exploratively examined longitudinal associations between previous symptom severity and subsequent use. As the agreement of different raters on child externalizing symptom severity is typically only low to moderate [4,5], we considered both caregiver and clinician ratings of child externalizing behavior symptoms to obtain a more comprehensive impression of their associations with use. Moreover, as previous research has often been criticized for considering only 1 possible measure of use, we considered both the number of log-ins (frequency of use) and the percentage of completed materials (intensity of use) to operationalize use. However, we chose to consider the number of log-ins for our primary analyses, as this is the measure most often used in previous research [29]. The study was based on the use of WASH PMT in terms of automatically tracked objective measures (number of log-ins, percentage of processed content) of using an online treatment, in which caregivers are free to take an interest-based approach in processing the training [22]. Findings for associations between the percentage of completed materials and child externalizing behavior symptoms are presented in a supplementary manner. The ultimate aim is to

provide a basis for improving internet-delivered interventions, in turn contributing to the further development of an effective therapeutic supply for children with externalizing behavior disorders.

Methods

Study Design

Data for the analyses were collected as part of an effectiveness study on WASH [21]. The research compared 3 study conditions: (1) WASH alone, (2) WASH plus telephone-based support (WASH+SUPPORT), and (3) treatment as usual (TAU). The analyses included data from the first 2 conditions only. There were no restrictions regarding the use of further treatment options during study participation.

The RCT from which data for the analyses were gathered was registered at the German Clinical Trials Register (identifier: DRKS00013456; registered on January 3, 2018).

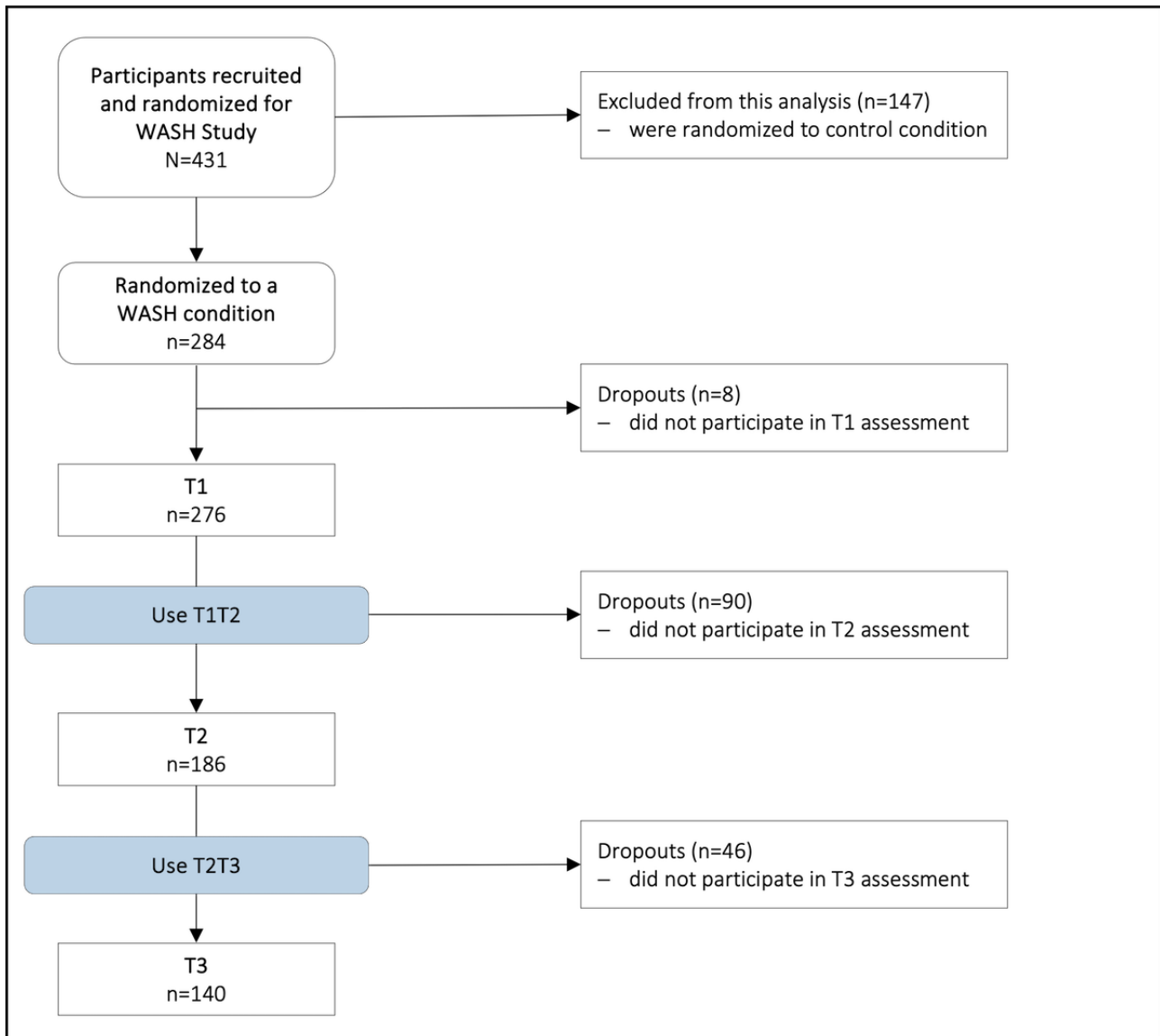
Ethical Considerations

This study was approved by the Ethics Committee of the Medical Faculty of the University Hospital Cologne (Germany; approval number: 17-273) and was performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. All participating caregivers provided written informed consent before randomization.

Participants

Participants were caregivers of children with externalizing behavior symptoms. The inclusion criteria were child age between 6 and 12 years and elevated levels of ADHD or ODD symptoms at the first assessment point (clinician rated during the caregiver interview). A diagnosis of mental retardation or autism spectrum disorder or an indication for inpatient treatment led to exclusion from the study. For subsequent analyses, we used a subsample of 276 caregivers who were randomized to the 2 intervention conditions: WASH (n=135, 48.9%) and WASH+SUPPORT (n=141, 51.1%); see Figure 1. Participating caregivers (n=147) in the control condition (TAU) were excluded from the analyses as they did not use the intervention, and thus, we could not assess use in this group.

Figure 1. Participant flow. Note. T1: before the intervention; T2: in the middle of the intervention; T3: after the 6-month intervention; WASH: web-based self-help.



Intervention

The online intervention was based on previous manual-based self-help programs that have proven effective in reducing children's ADHD or ODD symptoms [32-34]. The WASH intervention comprises 4 modules: solving behavioral problems, positive relationship with your child, self-care, and psychoeducation. We provided recommendations regarding usage, but caregivers were generally free to navigate the program according to their interests. Participants in the WASH+SUPPORT group received up to 6 support calls from a trained and supervised professional. A detailed description is provided in the published study protocol [21]. Participants in both study conditions received reminders if they had not logged in within 5 days after randomization. Users in the WASH group were then free to use the program and were contacted for assessment (12 weeks, T2; 24 weeks, T3 after T1). Although there was a significant overall intervention effect on child externalizing behaviors, as rated by a blinded clinician (Döpfner et al, unpublished data, August 2024), the superiority of the WASH+SUPPORT condition over the WASH condition,

revealed by subsequent pairwise comparisons, was compensated in this analysis by using the condition as a covariate.

Measures

Data were collected using a semistructured, telephone-based caregiver interview by a trained clinician and caregiver-rated online questionnaires before the intervention (T1), at a 3-month interim assessment point during the intervention (T2), and after the intervention (ie, at 6 months, T3).

Child Externalizing Behavior Symptoms

At each assessment point, a clinician rated the child's externalizing behavior symptoms based on a semistructured interview with the participating caregiver ("Diagnostic Checklist for Externalizing Behavior Disorders," DCL-EXT), conducted over the phone [35]. The interview covered ADHD symptoms (18 items) and ODD symptoms (8 items) according to the *International Classification of Diseases, 10th Revision (ICD-10)* and the *Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5)* and has been proven to be a high-quality diagnostic instrument for externalizing behavior disorders [36].

For our analyses, an overall externalizing symptom score was calculated by averaging all item scores. In the study sample, the internal consistency of this score was satisfactory (Cronbach $\alpha=.79$).

Corresponding to the clinician ratings, at each assessment point, caregivers rated their children's externalizing behavior symptoms using 18 items of the German Symptom Checklist for ADHD and 8 items of the ODD subscale of the Symptom Checklist for Disruptive Behavior Disorders ("Symptom Checklist for Externalizing Behavior Disorders," SCL-EXT) [35]. The items were answered on a 4-point Likert scale (ranging from 0 for *not at all* to 3 for *very much/particularly severe*) [35]. Again, the total externalizing symptom score (SCL-EXT) was computed by averaging all item scores. The instruments have demonstrated factorial validity and satisfactory internal consistency [35,37,38]. The internal consistency in the study sample was satisfactory (Cronbach $\alpha=.90$) for the combined total SCL-EXT score.

Intervention Use

For each caregiver, an automatically generated log file was extracted 3 months after baseline (at T2) and 6 months after baseline (at T3), including the number of log-ins (ie, frequency of use) in the first 3 months (T1-T2) and the next 3 months (T2-T3), respectively [39,40]. Beyond that, we calculated the percentage of completed tasks/videos (ie, intensity of use, %) between T1 and T2 or between T2 and T3 for each participant by dividing the number of finished tasks and videos in a module/for a specific situation by the maximum number of tasks and videos provided in that module [22]. Reliability analyses for this processing progress scale yielded an acceptable internal consistency (Cronbach $\alpha=.78$).

Statistical Analysis

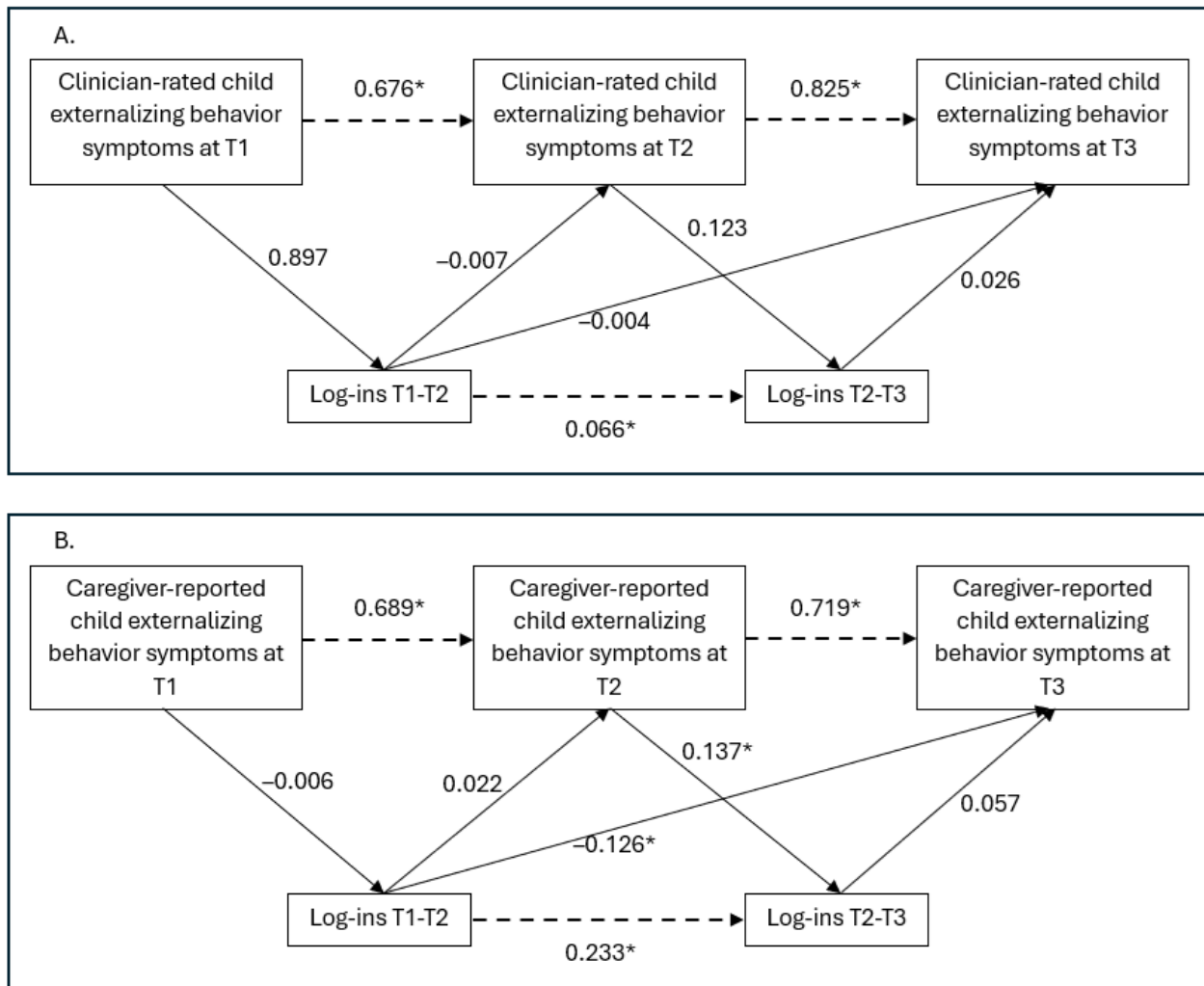
Analyses were conducted on the sample with complete questionnaires for at least T1. Before the main analyses, which included data from participants in both study conditions, independent samples *t* tests were performed to test for differences in child externalizing behavior symptoms between the study conditions at T1. To examine whether child externalizing behavior symptoms affect caregivers' use of the WASH intervention and vice versa, we performed path analyses. In these analyses, we considered associations between the severity of child externalizing behavior symptoms at T1 and the caregivers' use of the WASH intervention in the early

intervention period (between T1 and T2), as well as associations between caregivers' use in the early intervention period and child externalizing symptom severity at T2. Accordingly, we regarded the associations between symptom severity at T2 and caregivers' use of the program during the late intervention period (between T2 and T3), as well as associations between this use in the late intervention period and symptom severity at T3. In addition to these paths, to account for temporal stability, we considered autoregressive correlations between child externalizing behavior symptoms measured at the different assessment points and between the use parameters assessed between the assessment points (see Figure 2).

The use of WASH took place between the measurements of children's externalizing behavior symptoms. For our main analyses, we examined 2 different models, with externalizing behavior symptoms rated by either clinicians (see Figure 2A) or caregivers (see Figure 2B) and with caregivers' frequency of use of WASH operationalized by the number of log-ins (log-ins in months 0-3 and log-ins in months 3-6). We chose this measure of use for our primary analyses as it has been reported in most of the previous research on use-symptom association and, thus, allows for comparability with previous findings. Moreover, due to automatic data tracking, this measure seems reliable. However, we additionally conducted analogous analyses on the question of whether the results can be replicated when using a different operationalization of use (ie, percentage of completed materials; intensity of use). The findings for these additional analyses are presented in the online supplement for this paper. In all analyses, we controlled for the effect of the study condition (WASH and WASH+SUPPORT) on the use parameters and on symptoms.

We reported standardized parameter estimates (β). To evaluate the model fit, we considered the comparative fit index (CFI) and the standardized root mean square residual (SRMR), in addition to χ^2 . In line with current recommendations, we considered CFI>0.90 and SRMR<0.08 as acceptable [22,41]. Despite its frequent use, we refrained from relying on the root mean square error of approximation (RMSEA), as this index is not suitable in the case of low degrees of freedom [42]. The analyses were conducted using the Statistical Package for the Social Sciences (SPSS) version 27 (IBM Corp) for descriptive statistics and *t* tests and Mplus version 7.4 (Muthén & Muthén) for path analyses.

Figure 2. Results of the path models examining the association between the caregiver's number of log-ins to the WASH intervention and clinician-rated (A) or caregiver-rated (B) child externalizing behavior symptoms. Note. Log-ins T1-T2: number of log-ins during the early intervention phase (months 0-3); log-ins T2-T3: number of log-ins during the late intervention phase (months 3-6); Tx: measuring time; dashed line indicates autoregressive directional correlations; * $P < .05$.



Results

Sample Description

Table 1 summarizes the demographic and clinical characteristics of the participating caregivers and their children. At T1, on average, clinicians indicated elevated levels of child externalizing behavior symptoms (DCL-EXT: mean 1.52, SD 0.36). Likewise, caregivers reported clinically relevant child externalizing behavior symptoms (SCL-EXT: mean 1.70, SD 0.46). The independent samples t tests revealed no significant differences between the 2 intervention conditions in caregiver-reported child externalizing behavior symptoms at baseline ($t_{282}=1.32$, $P=.19$). After 6 months (DCL-EXT T3: mean 1.08, SD 0.44; SCL-EXT T3: mean 1.36, SD 0.50),

symptom levels were still considered as elevated, according to orienting evaluation without normative standards [35]. However, both clinician-rated ($t_{193}=16.33$, $P<.001$) and caregiver-rated ($t_{158}=10.70$, $P<.001$) child externalizing behavior symptoms declined significantly between T1 and T3.

On average, caregivers logged in to the WASH intervention 5 times (SD 4.38, range 0-18) during the early intervention period (months 0-3), with significantly fewer log-ins (mean 0.53, SD 1.20, range 0-9) during the late intervention period (months 3-6; $t_{275}=17.40$, $P<.001$). Additionally, the percentage of completed material was significantly higher in the first intervention period (mean 31.88, SD 26.08, range 0-96.70) than in the second intervention period (mean 1.93, SD 5.83, range 0-31.20; $t_{275}=18.76$, $P<.001$).

Table 1. Demographic information about caregivers and children (N=276).

Variable	Value
Caregivers	
Sex (women), n (%)	254 (92.0)
Age (years), mean (SD, range) ^a	42.93 (5.95, 26.61-1.54)
Children	
Sex (boys), n (%)	226 (81.9)
Age (years), mean (SD, range)	9.35 (1.73, 6.00-12.97)
ICD-10^b diagnosis by local health care provider, n (%)	
Suspected ADHD ^c	64 (23.2)
F90.0 Hyperkinetic Disorders, Disturbance of Activity and Attention	160 (58.0)
F90.1 Hyperkinetic Conduct Disorder	42 (15.2)
F90.8 Other Hyperkinetic Disorders or Hyperkinetic Disorder and F90.9 Hyperkinetic Disorders or Hyperkinetic Disorder, Unspecified	4 (1.4)
F98.8 Attention-Deficit Disorder without Hyperactivity	6 (2.2)

^aReduced N=253 due to 1 missing value at baseline.

^bICD-10: *International Classification of Diseases, 10th Revision*.

^cADHD: attention-deficit hyperactivity disorder.

Associations of Caregivers' Use With Symptoms of Children

Results of the path analyses on the associations between the number of log-ins and changes in child externalizing symptom severity are reported in [Figure 2](#) and Table S1 in [Multimedia Appendix 1](#). The model fit was acceptable for both models (associations between clinician-rated child externalizing behavior symptoms and the number of log-ins: CFI=0.97, SRMR=0.03; associations between caregiver-rated child externalizing behavior symptoms and the number of log-ins: CFI=0.92, SRMR=0.04). Although significant, the χ^2 value depends strongly on the degrees of freedom, which, at $df=2$, were considered acceptable (see Table S2 in [Multimedia Appendix 1](#)) [43,44]. The primary analyses yielded no significant associations between the number of log-ins and clinician-rated child externalizing behavior symptoms (see [Figure 2](#) and Table S1 in [Multimedia Appendix 1](#)). A small significant negative association was found between the number of log-ins (months 0-3) and the caregiver-reported child externalizing behavior symptoms in the long term (T3; $\beta=-.13$, $P=.29$). Moreover, the caregiver-reported severity of child externalizing behavior symptoms at T2 was significantly associated with a higher number of log-ins in the later phase ($\beta=.14$, $P=.29$). The significant results must be classified as small effects based on the standardized β coefficient [45]. To examine whether the findings for the use-symptom associations may be replicated when using a different operationalization of use, we conducted secondary analyses according to the main analyses but applied the percentage of completed materials as a measure of use (see Table S3 in [Multimedia Appendix 1](#)). The model fit and χ^2 for both secondary models were acceptable, too (see Table S2 in [Multimedia Appendix 1](#)). No significant associations were found, neither when considering clinician

ratings nor when regarding caregiver ratings of child externalizing behavior symptoms.

Discussion

Principal Findings

To the best of our knowledge, this study is the first to systematically investigate the relationship between caregivers' use of an online intervention and changes in their children's externalizing behavior symptoms. Overall, use was low, especially during the second half of the intervention period. Our results hint at a bidirectional, albeit small, association between the caregiver's frequency of use (ie, number of log-ins) and changes in caregiver-reported child externalizing behavior symptoms. That is, first, the more log-ins during the early phase, the less severe the externalizing behavior symptoms reported by caregivers in the longer term. Second, in contrast, the more severe the caregiver-rated externalizing behavior symptoms, the more frequent the log-ins to the intervention in the subsequent late intervention phase (months 3-6). However, none of the other use-symptom associations in this model were significant. Moreover, we were not able to replicate these findings when we considered clinician-rated rather than caregiver-rated externalizing behavior symptoms, nor when we operationalized caregivers' use by the percentage of completed materials (intensity of use).

Consistent with research on the use of online treatment for depression, we found both more log-ins and higher task completion rates (frequency and intensity) in the first than in the second half of the intervention [46]. For the second intervention phase (months 3-6), the mean overall number of log-ins was low. Furthermore, the overall progress during the 6-month treatment was relatively low, with only about one-third of the program being processed, on average. In view of previous

research, it is clear that low completion rates are a general problem of internet-delivered interventions [20,47]. In fact, participants did not receive clear guidelines regarding use but were allowed to work on the intervention and content according to their interests, and full program completion was neither recommended nor necessary, since the program offers a wide range of options for usage and parents are asked to choose the components that best suit their needs. As previous analyses of the data used in this study revealed that personal telephone contact is a main predictor of enhanced use [22], the lack of counseling support calls (during months 3-6) might explain the significantly lower use in this period. The lower use in this period, which was additionally associated with lower variance (see Table S4 in [Multimedia Appendix 1](#)), may contribute to the explanation of the small effect sizes and the nonsignificant associations in the models, including clinician-rated child externalizing behavior symptoms or the percentage of completed materials as a measure of use.

Considering the findings of at least some associations between caregivers' use of the intervention and child externalizing behavior symptoms, the low use underlines the need for measures to foster engagement in online PMT to improve intervention outcomes. Previous research has demonstrated that use can be enhanced by some kind of support (eg, personal contact over the phone or chat functions, reminders) [22,48]. Contrary to previous findings of no significant use-symptom associations for PMT in the field of child anxiety disorders [25], our results hint at some longitudinal associations between the number of log-ins to the WASH intervention and caregiver-reported child externalizing behavior symptoms.

Notably, we not only found that (1) single aspects (frequency) of parental use of WASH are associated with externalizing behavior symptoms in the longer term but also observed that (2) externalizing symptom severity during treatment predicts later frequency of use. Although the effects were rather weak, and findings varied for different (but correlated) operationalizations of use ($r=0.73$, $P\leq.001$) [22], we consider these results as providing initial exploratory evidence for use-symptom associations. The different results for frequency and intensity of use underline the need for a differentiated consideration of these 2 parameters [30], as they capture 2 different facets of use. Although the number of log-ins merely reflects participation in the program, the percentage of use provides an indication of the depth of processing of the program content. Based on the available information from the study, we cannot conclude why significant associations with symptoms were found for the number of log-ins and not for the percentage of use. Maybe the different findings might be explained by influences of child characteristics, disorder characteristics (eg, symptom severity), or caregiver characteristics (ie, own inattention problems), which might be related to either use behavior and child externalizing symptom severity or both. However, further research is needed first to determine whether the results of this study may be replicated and then to examine further reasons for the differing results for the number of log-ins and the percentage of use.

The negative association between frequency of use and subsequent symptom severity could not be replicated when

regarding clinician-rated child externalizing behavior symptoms. Previous research on PMT aiming to compare/validate different outcome measures across different assessors (caregiver, teacher, clinician) has likewise found a lack of congruence across different raters [5]. The authors concluded that caregivers may overestimate the effects of PMT, potentially due to the resources they have invested in treatment use (effort justification). Moreover, changes in caregivers' perceptions of children's externalizing behavior symptoms lead to greater tolerance, leading them to rate behavioral problems as less severe [22]. Future research is needed to replicate our findings.

Overall, despite significant findings on some variables, the relationship between frequency of use and change in caregiver-rated child externalizing behavior symptoms is not strong. Thus, we may conclude that simply improving the use of the WASH program is insufficient to enhance treatment outcomes in clinical practice. Other factors that were not controlled for in these analyses may be more important for explaining the differences in outcomes and might be a more favorable starting point for improving interventions (eg, emotional and behavioral problems and competencies of the parents, quality of intervention implementation). For example, internet-delivered PMT—from a theoretical and practical perspective—seems to affect parenting skills or parental psychopathology [12,25], and previous research has demonstrated that the effects of PMT on child externalizing behavior symptoms are mediated by a change in (mainly negative) parenting behaviors [49]. A deeper examination of such additional factors and their interplay is necessary to obtain a more comprehensive impression of the processes leading to symptom changes and to draw conclusions on how to improve treatment outcomes in clinical practice. It is conceivable that the use of web-based PMT is a prerequisite for change in both child- and parent-related variables and that there is a complex interplay between these variables.

Future studies should examine more complex models, including additional moderators and mediators of the effects of web-based PMT on child externalizing behavior symptoms (eg, parental skills practice [12], parenting behaviors), and additionally focus on the use of individual techniques (eg, stimulus control, contingency management) to gain a deeper understanding of the relative contribution of treatment use and of the particular mechanisms that lead to symptom improvements. A combination of objective and subjective measures of the individual model components should be used to increase the validity of the findings. Moreover, measures to enhance treatment use (eg, additional support calls) and their relative importance for enhancing treatment outcomes should be examined in more detail. Recently, microtrials have examined the effectiveness of specific elements of face-to-face PMT (eg, stimulus control techniques vs contingency management) [50,51]. Transferring this approach to web-based PMT and linking it to the measures of treatment use may help further study and explain the associations between use parameters and symptom changes.

Strengths and Limitations

Although the study sample is larger than in many other studies, it is nevertheless small for this type of analysis, limiting the

possibility of detecting significant associations [52]. Moreover, several analyses were performed, increasing the risk of detecting significant effects by chance. Unfortunately, no measures on the practice and implementation (homework practice) of, for example, problem-solving strategies and contingency management into daily life were conducted. Moreover, we cannot guarantee that users engaged with the content rather than merely absolving the intervention, as we did not conduct knowledge quizzes to prove the CPE. The use variables are objective measures extracted from the program but do not indicate whether a caregiver changed parenting behaviors following treatment. Future research should include these variables (CPE in sessions and between sessions and parenting behaviors) to examine their contribution to symptom changes connected with caregivers' use of WASH.

The strengths of the study are that we used 2 objective measures of use metrics (log data) and assessed child externalizing behavior symptoms from 2 different perspectives (ie, caregivers and clinicians).

Conclusion

The analyses in this study provide some, albeit limited, support for the directional, longitudinal associations of (1) the caregiver's early number of log-ins to WASH with child externalizing behavior symptoms in the longer term and (2) the severity of child externalizing behavior symptoms as an immediate predictor of following frequency of log-ins during the late intervention period. Although the results were inconsistent across different operationalizations of treatment use and raters (clinician vs caregiver) and although the effects were rather weak, these analyses provide the first evidence for use-symptom associations in web-based PMT for child externalizing behavior problems. Future research could try to replicate the results and consider complex models, including mediators and moderators of treatment outcomes (eg, parenting behaviors, parental psychopathology, sociodemographic variables, and effective elements). Ultimately, the respective results could be used to develop measures to improve the use of (web-based) PMT in clinical practice to enhance treatment outcomes.

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Data Availability

The data sets used and analyzed during the study are available from the corresponding author upon reasonable request.

Conflicts of Interest

CD receives royalties for self-help books for parents and teachers of children with attention-deficit hyperactivity disorder, published by Hogrefe. MD and JP receive royalties from publishing companies as authors of books and treatment manuals on parent management training and assessment manuals. None of the other authors of this study report any conflicts of interest.

Multimedia Appendix 1

Parameters for main analyses, model fit for all path models calculated on the association of use with the child's overall externalizing symptoms, parameters for secondary analyses, and description of usage parameters (early and late).

[DOCX File, 25 KB-Multimedia Appendix 1]

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Abbreviations

ADHD: attention-deficit hyperactivity disorder
CFI: comparative fit index
CPE: caregiver participation engagement
DCL-EXT: Diagnostic Checklist for Externalizing Behavior Disorders
ICD-10: *International Classification of Diseases, 10th Revision*
ODD: oppositional defiant disorder
PMT: parent management training
RCT: randomized controlled trial
SCL-EXT: Symptom Checklist for Externalizing Behavior Disorders
SRMR: standardized root mean square residual
TAU: treatment as usual
WASH: web-based self-help

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4 Discussion

In the following chapter, findings from the analyses presented in the two publications from Chapters 2 and 3 will be summarized and discussed. WASH, in combination with therapist support by telephone, has been found to be superior to routine clinical care and to WASH alone in reducing clinician-rated child externalizing symptoms (Döpfner et al., under review). It is obvious that for an intervention to be effective, its utilization is a prerequisite (Chiu & Eysenbach, 2010). Therefore, the general focus of the present thesis was the analysis of the utilization of WASH: First, the description and analysis of the acceptance and utilization of WASH (Wähnke et al., 2024) and second, its relevance for the change of child externalizing symptomatology (Wähnke, in press 2024). A particular aim of the thesis was the identification of predictors of acceptance and utilization (Wähnke et al., 2024). These findings extend the research in this field by a multidimensional description of the acceptance and utilization of WASH in terms of subjective and objective measures. Moreover, factors that predict acceptance (objective) and caregiver utilization (frequency and intensity) can be used to implement the intervention and recommend it more effectively. To the best of my knowledge, this thesis closes a research gap regarding the association of digital PMT usage and child externalizing behaviour.

Acceptance. Our subjective and objective measures suggest high parental acceptance of WASH (Wähnke et al., 2024). The comparison of different survey methods in our study suggests that acceptance via self-report was higher than the actual use and take up or return (objective measures) to the intervention. Descriptively, in this study, most caregivers (T2: $n=187$) reported to have used the intervention (91.4%) and that they would recommend the intervention (95.9%) (cf. Wähnke et al., 2024). Indeed, 85.9% of the participating caregivers (T1: $N=276$) took up the intervention (i.e. had at least one login), of which 71.4% returned for a second login (objective measure). These results support previous statements that a multidimensional description is needed to grasp the entire construct (Rost et al., 2017). Although objective data tracking received a lot of attention, qualitative and subjective assessments are advisable for receiving information on, e.g., reasons for (dis)continuing a treatment. This information is very much needed, as attrition of caregivers in different formats of PMT poses a threat to evidence-based treatment for children with ADHD/ODD (McGoron & Ondersma, 2015).

In fact, the reported acceptance rates of the WASH study do not allow for a clear view of why parents accept or do not accept the intervention. To obtain this information, more direct feedback is needed, e.g., in the form of assessing the caregiver's expectations of and attitudes towards the intervention. Acceptance can be seen as both a complex psychological construct influenced by attitudes and other factors and as a straightforward measure of whether someone starts the intervention. Due to this ambiguity, the terms uptake rate and return rate were introduced in this study to achieve a clear conceptual distinction between the sometimes very complex constructs. Some research groups define acceptance based on the Technology Acceptance Model by Davis (1989) on two factors:

perceived usefulness (whether one expects the intervention to be helpful in their situation/task) and perceived ease of use (whether technology is easy to use). A recent study applied individual interviews and the User Experience Questionnaire by Laugwitz, Held, and Schrepp (2008) to assess user acceptance. To the best of my knowledge, there is no gold standard regarding the assessment of acceptance, and future research should address the implementation of a standardization, potentially based on objective and subjective measures aiming at an integration of the Technology Acceptance Model. The present study results clearly show how important clear terminology is in the context of acceptance research so that study results can be categorized and no false conclusions are drawn. In this thesis, objective measures (uptake and return rate) were used to operationalize acceptance as the dependent variable, as these were found to be more reliable than the subjective measures (e.g., self-report of acceptance). The subjective data have a higher risk of systematic measurement error because of the social desirability of the responses (e.g., agreement to use and satisfaction with the intervention).

The CART results indicate that it is mostly a combination of individual variables of the caregiver (e.g., positive parenting, psychopathology, age) and child (e.g., externalizing symptom scores, age) that predicts acceptance in terms of uptake and return rate. Both the initial acceptance and return to the intervention were influenced by several factors (Wähnke et al., 2024). These factors include the child's ADHD/ODD symptoms, the caregiver's psychopathology (such as depression, anxiety, and stress), and their parenting style. For a small subset of caregivers, an exceptionally high level of self-reported positive parenting (top end) was associated with non-acceptance, meaning they did not initially take up the program (Wähnke et al., 2024). The variable "positive parenting" exclusively predicted non-acceptance. It can be assumed carefully that these caregivers already have very good parenting fundamentals and, therefore, do not expect the intervention to improve their individual performance. According to Uncovska, Freitag, Meister, and Fehring (2023), based on the *Theory of Acceptance and Use of Technology with Performance expectancy*, the intention to use mobile health apps or digital healthcare applications (DiGA) is predicted by performance expectancy, self-efficacy and attitude toward the intervention. Self-efficacy and greater parental confidence have also been found to be predictive factors for higher module completion in an online parenting program (Triple P) for externalizing childhood disorders (Day et al., 2021). In contrast, parents with very high positive parenting scores will possibly feel self-effective enough and, therefore, do not expect further gains in taking up a low-threshold online intervention. This predictor also appeared in the decision paths related to return rates, indicating that caregivers with high levels of positive parenting, along with having received less than two support calls and higher levels of ADHD symptoms, might not perceive the program as beneficial for their situation (Wähnke et al., 2024). Furthermore, even when they accept the intervention,

these caregivers (with self-reported high positive parenting) tend to use the intervention less frequently and with less intensity (Wähnke et al., 2024; as seen in Figure 5 and Figure 6). This suggests that the intervention may be less effective for this specific population. However, the results of this study indicate that it is not a single predictor but a multifactorial model, combining factors such as the child's symptom severity as well as the caregiver's and child's age to predict a caregiver's acceptance of the intervention.

The number of support calls emerged as the most significant predictor for the return to the program, with a higher number of support calls increasing the likelihood of return (Wähnke et al., 2024). This finding aligns with previous research (Rost et al., 2017). Concluding: a potential way to reduce attrition and promote a return to the intervention seems to be personal contact via telephone-based support calls, which enhances the chance of returning to the intervention (Wähnke et al., 2024). To complement this research, we conducted further CARTs on the dependent variable *satisfaction* (measured by self-reported client satisfaction questionnaire; see the WASH study protocol by Döpfner et al., 2020), resulting in overall comparable results.

Utilization. Caregivers used the WASH intervention significantly more often and intensively in the first three months of a six-month intervention than in the second half of the intervention period (Wähnke et al., 2024). These results are in line with previous research analyzing the utilization of internet-delivered interventions for individuals with depressive symptoms (Enrique, Palacios, Ryan, & Richards, 2019). Since our overall findings suggest higher utilization scores for the guided intervention group (WASH+SUPPORT), we assume that guidance can support families not only in the early treatment period but throughout the whole process of WASH, keeping caregivers engaged and, at length, achieving symptomatic improvements (Wähnke et al., 2024). Moreover, research indicates that the termination of additional support led to treatment dropout (Lawler, Earley, Timulak, Enrique, & Richards, 2021), providing support for the need for additional assistance with an unguided WASH.

Data tracking resulted in an average number of logins ($M=5$) corresponding to the initial recommendation (six sessions) quite well, and most participants viewed each module as recommended (Wähnke et al., 2024). However, the rate of completed tasks (intensity, in %) was relatively low, with $M=31.88\%$ of the total program being processed. Indeed, caregivers were able to see their progress in the intervention, referred to by a pie chart. However, as mentioned, the full completion was neither expected nor recommended. A non-binding, written recommendation was offered to the participants of the WASH study as a rather soft orientation, which did not contain a specific completion recommendation (Döpfner et al., 2020).

In summary, these results contribute to the previous research emphasizing the influence and importance of some form of guidance by a coach/ therapist for the utilization of web-based self-help PMT (Thongseiratch, Leijten, & Melendez-Torres, 2020). Nevertheless, low completion rates are a

general problem of internet-based interventions (MacDonell & Prinz, 2017; Rooksby, Elouafkaoui, Humphris, Clarkson, & Freeman, 2015). Treatment dropout (from a DBCI for adults with depression and anxiety), on the one hand, has been found to be due to either readiness to leave early or, on the other hand, due to actual perceived negative aspects of participation (Lawler et al., 2021). Considering these findings, together with the non-specific recommendation we provided with the intervention, it can be assumed that these reasons may provide hints for the low completion rates of WASH. In fact, satisfaction with the intervention was high, with 95.9% of the participating caregivers agreeing they would recommend the intervention to a friend, which may promote the thesis that caregivers were *ready to leave the intervention*. However, as this thesis did not include concrete reasons for quitting WASH, we cannot finalize this discussion and promote further research to address this research in the future.

Factors of acceptance and utilization. Considering a lack of improvement in the general effectiveness of psychosocial therapy for ADHD (Weisz et al., 2018), other ways of improving the treatment accessibility of those therapeutic interventions that are known to be effective in reducing child behavior problems are needed. Based on the scientific evidence of web-based parent management training, we should focus on the factors that affect caregiver participation in innovative treatment formats such as WASH. On the one hand, in line with previous research (Tarver, Daley, & Sayal, 2021; Thongseiratch et al., 2020), telephone-based support has been found to be a main predictor of higher frequency and intensity of use in the present analyses (Wähnke et al., 2024). On the other hand, consistent with adult-addressed interventions, our results indicate that the acceptance and utilization of WASH depend on specific socioeconomic and psychopathological factors of the user (Perski, Blandford, West, & Michie, 2017; Wähnke et al., 2024). Moreover, the results of this study show that not just the user's personal variables but the caregiver's child variables, in particular psychopathological factors, are predictive of parental acceptance and utilization of the intervention (Wähnke et al., 2024). In comparison, previous research found single variables such as user age and educational attainment to predict intervention usage (Perski et al., 2017). The statistical method we employed allows various predictors and their classification to various decision paths to account for predictive influences (Wähnke et al., 2024). Whereas previous qualitative research considered the factor "presence of siblings" as a barrier to attending online caregiver interventions (Tarver et al., 2021), CART allows us to specify that with more than four people per household, the intervention will be less likely to be used (Wähnke et al., 2024). However, this variable has been only found in a decision path of further predictors. It should therefore be considered and interpreted in combination with the following characteristics: caregivers with less than two support calls, a very high caregiver-reported score of ODD symptoms, and more than four people per household have been found to log in at least once (Wähnke et al., 2024). In general, predictive variables found in CART were consistent across different utilization parameters,

e.g., higher caregiver age was predictive of more often and more intensive use (and even of uptake). However, some variables differed in the way they classified the sample to the CART leaves: e.g., the number of support calls (two support calls predicted the number of logins, and six support calls predicted intensity of usage in %). Overall, predictive variables were similar for the conducted decision trees (i.e., uptake, return, frequency, and intensity of usage), with certain variables found not to predict any of the analyzed constructs (Wähnke et al., 2024). Further variables that have been found to be part of the prediction paths of different utilization parameters are the severity of ODD symptoms, ADHD-related skills, parental sociodemographic factors (e.g., marriage/partnership status, people per household, afternoon care, educational attainment, age), parental psychopathology and positive parenting.

Utilization-symptom change association. In previous research, it remains unclear how exactly caregiver usage is related to reported changes in child symptomatology in PMT for reducing externalizing symptomatology. Research results of the first study (Wähnke et al., 2024) indicated that there is an association between the utilization of WASH and the caregiver-reported child symptoms: the child's ADHD and ODD symptoms, as well as other externalizing symptomatology-related measures, have been found to be significant predictors. Results of the second study (Wähnke et al., in press 2024) hint at a possible bidirectional, though small, relationship between caregiver utilization (number of logins) and caregiver-reported child symptom changes. Although the effects found in the path analyses were rather weak, we consider these findings as exploratory evidence for the under-researched field of the utilization-symptom change association in PMTs: First, the number of logins to WASH is associated with caregiver-reported externalizing symptoms of the child at post-measurement, indicating higher numbers of logins to improve decrease of symptoms in the longer term (Wähnke et al., in press 2024). Second, more severe child externalizing symptoms at pre-measurement are associated with subsequently more logins at post-measurement (Wähnke et al., in press 2024).

Based on a semi-structured caregiver interview, these results could not be replicated for clinician-rated child symptoms. This corresponds to previous research, which did not find evidence for the effectiveness of PMT on clinician-rated core ADHD symptoms (Daley et al., 2018; Rimestad, Lambek, Zacher Christiansen, & Hougaard, 2019; Sonuga-Barke et al., 2013). Taking into consideration that key factors of acceptance of eHealth interventions are self-efficacy and performance expectancy, it may be assumed that caregivers subjectively experienced a greater effect of the intervention than clinicians and reported a greater reduction of the child's symptomatology. Based on theory and previous research, caregivers who actively participated in the treatment and study may experience themselves as more self-efficient, and that is, they may also rate their involvement in reducing the child's symptomatology as higher (Uncovska et al., 2023; Venkatesh, Morris, Davis, & Davis, 2003; Venkatesh, Thong, & Xu, 2012). Furthermore, the path model results of the secondary analysis varied

for the different operationalizations of utilization. The inconsistent findings across different variables in the analyses can be interpreted as a hint for potential other variables that may influence the findings as they might be related to the utilization or child symptoms, such as child characteristics, disorder characteristics (e.g., symptom severity), or caregiver characteristics (i.e., own inattention problems) and quality of the implementation of treatment content (cf. Wähnke et al., in press 2024). Recent research found relationship-related factors (i.e., positive parent-child relationship/ interaction) to be the strongest predictors of a change in child conduct problems following parent training (Dedousis-Wallace, Drysdale, McAloon, & Ollendick, 2021). Other studies showed that sending reminders to work with an online program has been found to be “the most important way to yield high effectiveness” (Thongseiratch et al., 2020). Moreover, the authors of meta-analyses conclude that less severe conduct problems lead to fewer benefits from parenting programs (Leijten et al., 2020). Combining this thesis's findings and previous research results, there seems to be a need for further research on the utilization-symptom change association in web-based PMT. However, as the CART analyses in this thesis show, often, it is not just one predictive variable but a combination of various variables that explains and predicts outcome measures.

4.1 Strengths and Limitations

The present thesis allows for new insights into aspects of acceptance and utilization of web-based self-help for parents of children with externalizing behavior problems. Above all, a major strength of this research is the multidimensional approach we applied in the description of acceptance (uptake, return, satisfaction) and utilization (e.g., duration of usage, uptake time, number of logins, completed tasks) parameters as well as the predictor analyses which were conducted on different dependent variables.

The CART method also supports this multidimensional approach, allowing us to gain a multifactorial understanding of which factors drive acceptance and utilization. These results contribute not only to previous research but also offer practical applicability, as their visual representation makes them easy to interpret and implement in daily pediatric and therapeutic practices (Wähnke et al., 2024).

In addition, we chose and were able to report objective as well as subjective data for the acceptance and utilization parameters, thus meeting the demands of researchers. The automatic data tracking enhances the informative value of the research.

Moreover, we exploited commonly used and psychometrically tested outcome measures to assess predictors such as child externalizing symptomatology (SCL-ADHD/ODD), parental psychopathology (DASS), and parenting behaviour (PNPQ). This allows future research to relate to findings and clarify divergent research findings.

On the other hand, the present thesis adds to the few studies that explicitly examined the associations between parental utilization and child externalizing behaviour changes (Wähnke et al., in press 2024). Moreover, we provide different models, including the specific analyses of ADHD and ODD, which allow greater insight as well as the implications for whom the intervention may be effective. Again, we chose a multidimensional analysis for the second study to further clarify the connections, as there is a knowledge gap or disagreement in research here.

Besides the various strengths of this thesis, as in any research, there are limitations that need to be considered. Above all, the sample generally included rather high socioeconomic status families, which reduces the generalizability of the results and the practical applicability of the decision trees.

Due to possible missing logouts, automatic data tracking regarding time spent with the intervention can be subject to measurement errors. In addition, we did not conduct any knowledge quizzes to prove engagement with the intervention's content, nor did we ask whether caregivers implemented the strategies and information into daily life. We cannot guarantee that the participants in the study did not just “click-through” the intervention.

Finally, an important limitation of the study results lies in the small amount of variance explained by parental utilization of the intervention, especially for the second study: the overall small effects of the study indicate that there may be other variables more important than those considered here in explaining the change in child symptoms (Wähnke et al., in press 2024).

4.2 Conclusion and Implications

Regarding the high prevalence of ADHD and ODD among children and adolescents, the necessity for targeted and efficacious interventions becomes evident. Web-based self-help parent management training emerges as a potentially feasible treatment with relatively low barriers compared to other formats of PMT. By better comprehending the mechanisms of utilization that have been found to be associated with child outcomes, clinicians may be able to implement WASH in a target group more effectively.

In general, the results of the present thesis point to WASH as a well-accepted parent-directed intervention in the context of child ADHD and ODD treatment under RCT conditions. This thesis, *inter alia*, aimed at the description of parameters to compare acceptance. After all, it remains unclear whether objective and/or subjective assessments are more suitable or equivalent to this aim. Based on the results of this thesis, we recommend a combination of both forms, although the descriptive rates and prediction findings indicate minor differences. These could be analyzed further in future studies.

If clinicians assume that there are no single aspects but multiple interrelated factors that might play a role in the attendance of WASH, healthcare professionals can improve their provided ADHD and/or ODD treatment.

Personal contact (in this case, telephone-based support) is a factor clinicians should consider during treatment, at the beginning to get caregivers started, and possibly during the whole treatment, as this might reduce drop-out rates of online PMT. To enable the guidance of the intervention, it requires clarification and reduction of structural barriers (e.g., time and privacy concerns), especially for those who act as multipliers (clinicians, therapists, and other healthcare providers) in the context of healthcare (cf. Weitzel et al., 2023). This is particularly important, as personal contact (e.g., via telephone) is one of the main factors that have been found to be associated with acceptance and utilization. Due to its relevance, we ask future researchers to analyze the requirements of additional support conditions in terms of the special qualifications of the advisor and temporal aspects.

Taking together the results of the two presented studies, one may conclude that caregiver-reported child symptomatology drives utilization. On the other hand, the results of study 2 point to the direction that caregiver utilization, in turn, drives caregiver-reported child symptom changes. These results are seen as the first evidence of the directional relationship between caregiver utilization and caregiver-reported child symptom change. These results could not be replicated in the clinician-rated child symptomatology. Future research should try to investigate the utilization-symptom change associations in more complex models (e.g., including factors of parental psychopathology and parenting).

Considering the symptom change reported by the caregiver who attended the program, this supports previous demands on the development of equivalent school-centered interventions to reduce barriers to teacher-related treatment, which have been found to achieve significant teacher-rated improvements in ADHD symptoms (Corkum, Elik, Blotnick-Gallant, McGonnell, & McGrath, 2019). In German-speaking countries, there are innovative endeavours in the form of cooperation projects (e.g., <https://teaching-adhd-children.eu>) for web-assisted self-help for teachers based on teacher coaching (Hanisch, Richard, Eichelberger, Greimel, & Döpfner, 2018).

Overall, the findings of this research should be considered a promising intervention to address the chronic undersupply of children and adolescents (cf. Husky et al., 2020) as well as the mental health crisis anticipated by high-level researchers (The Lancet Infectious, 2020) and the challenges (e.g. increasing psychological problems in children and adolescents, parental stress) resulting from the COVID-19 pandemic (Fitzpatrick, Carson, & Weisz, 2020; Ravens-Sieberer et al., 2020).

4.3 References Discussion

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5 Appendix

5.1 Additional Files: Acceptance and utilization of web-based self-help for caregivers of children with externalizing disorders

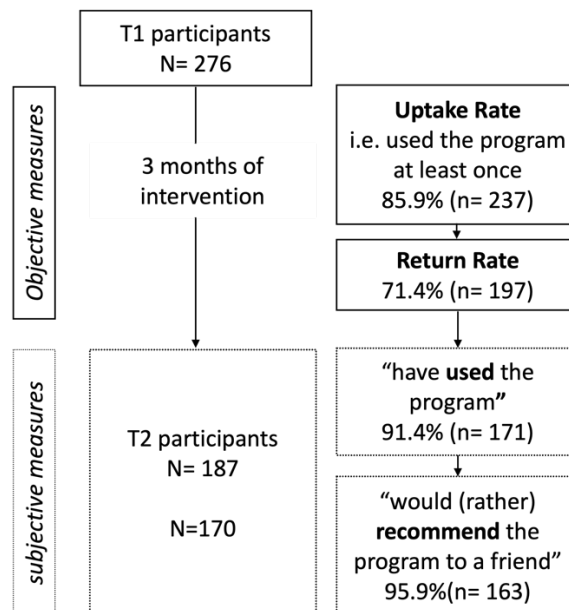
Supporting Material for *Acceptance and utilization of web-based self-help for caregivers of children with externalizing disorders* by Wähnke et al. 2024

Additional file 1 Child- and Parent-Related Healthcare Services Usage

	never		only in the past		until today	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Child-related health intervention						
psychotherapy	166	60.1%	37	13.4%	73	26.4%
occupational therapy	73	26.4%	122	44.2%	81	29.3%
physiotherapy, movement therapy	222	80.4%	46	16.7%	8	2.9%
pharmacological treatment	117	42.4%	12	4.3%	147	53.3%
Parent-related health intervention						
parent management training	232	84.1%	33	12.0%	11	4.0%
self-help group	253	91.7%	9	3.3%	14	5.1%
internet-based self-help	264	95.7%	7	2.5%	5	1.8%

Note. *N*=276 total sample size

Additional file 2 Measures of acceptance



Additional file 3 Content, Views and Intensity of Use (%) per Module

Module		Content	Viewed ¹	Intensity of Use (%) ²			
Situation				M	SD	Min	Max
Module 1	Solving behavioral problems		237 (85.9%)	34.73	21.41	0	100.00
	Situation 1	Temper tantrum	175 (63.4%)	19.99	26.69	0	98.28
	Situation 2	Homework	182 (65.9%)	14.11	22.45	0	83.67
	Situation 3	Chaos in child's room	126 (45.7%)	8.22	20.08	0	100.00
	Situation 4	Constant interruption	249 (90.2%)	7.78	15.80	0	83.67
	Situation 5	Media consumption	124 (44.9%)	9.57	21.85	0	90.00
	Situation 6	Sibling conflicts	161 (58.3%)	7.07	17.46	0	89.80
	Situation 7	Restlessness at meals	162 (58.7%)	6.02	15.08	0	85.71
Module 2	Positive relationship		237 (85.9%)	41.79	38.18	0	100.00
Module 3	Self-care		237 (85.9%)	13.80	22.50	0	96.15
Module 4	ADHD-What is it?		205 (74.3%)	53.20	42.71	0	100.00
Module 1 – 4	Total Utilization		237 (85.9%)	31.17	26.18	0	96.70

Note. ¹ number of participants who have seen any of the content in this module or situation, ² mean percentage of completed tasks achieved by participants within each module or situation.

Additional file 4 Correlation of Utilization Dimensions

	Correlation <i>r</i> of utilization parameters			
	Intensity (process, %)	Uptake Time (days)	Frequency (number of logins)	Duration (minutes)
Uptake time ^{a)} (days)	-.23**			
Frequency (number of logins)	.73**	-.29**		
Duration ^{b)} (minutes)	.39**	-.10	.43**	
Support calls ^{c)} (number)	.38**	-.10 ^{d)}	.27**	.08

Note. ^{a)} *n*=237; ^{b)} *n*=254, variable corrected for outlier values; ^{c)} *n*=141; ^{d)} *n*=126; **p*≤.01; ** *p*≤.001.

Additional file 5 Active and Passive Utilization

		Active utilization (tasks) <i>n</i> =276				Passive utilization (videos) <i>n</i> =276				Statistics			
		M	SD	Min	Max	M	SD	Min	Max	<i>t</i>	<i>p</i>	<i>d</i>	<i>r</i>
Module 1	Solving behavior problems	53.6	34.78	0	100	44.68	38.90	0	100	-4.206	<.001	-.25	.46**
Module 2	Positive relationship	44.42	39.32	0	100	39.04	39.60	0	100	4.100	<.001	.25	.85**
Module 3	Self-care	13.27	21.46	0	95.24	16.88	43.67	0	100	-2.358	.02	-.14	.68**
Module 4	ADHD-What is it?	55.54	46.93	0	100	49.73	42.08	0	100	3.057	.002	.18	.75**
Total		32.34	26.67	0	95.83	35.30	28.80	0	100	-2.343	.02	-.14	.72**

Note. Utilization, i.e. completed tasks or videos in % (intensity of utilization).

Additional file 6 Decision Paths for CART Decision Trees

Decision paths are reported starting at the maximum (i.e. right end node) for each dependent variable, then inline leftwards.

Nodes	Decision tree predicting initial uptake of the WASH intervention
1	If the reported value on the PNPQ (scale: positive parenting) < 3.6, the value for ADHD symptomatology < 2.7, the value for ADHD skills and reflectivity < 1.8, and the caregiver's age (in years) ≥ 38, then caregivers were likely to take up the intervention (n=180 (65.2%) acceptor/ n=14 (5%) non-acceptor).
2	If the reported value on the PNPQ (scale: positive parenting) < 3.6, the value for ADHD symptomatology < 2.7, the value for ADHD skills and reflectivity < 1.8, the caregiver's age (in years) < 38, the child's age < 11 and the value for ADHD skills and reflectivity is ≥ 0.25, then caregivers were likely to take up the intervention with 15 % taking up and only 2 % not taking up.
X	Due to very small subsamples (n=5-7) and nearly 50/50 ratio for initial uptake or no initial uptake, no decision paths predicting no initial uptake are reported at this point but can be read from the presented Figure 3.

Nodes	Decision tree predicting return after initial uptake of the WASH intervention
1	If caregivers received ≥ 2 support calls and the reported value for ADHD symptomatology ≥ 1.3, then caregivers were more likely to return to the intervention for login (n=84 return/ n=7 no return).
2	If caregivers received ≥ 2 support calls, the reported value for ADHD symptomatology < 1.3 and the reported value for ADHD skills and reflectivity < 1.3, then caregivers were likely to return to the intervention for login (18/4).
3	If caregivers received ≥ 2 support calls, the reported value for ADHD symptomatology < 1.3 but the reported value for ADHD skills and reflectivity ≥ 1.3, then the relation of caregivers that did not return to the intervention for login changed (5/4), resulting in a tendency towards a higher risk of not returning.
4	If caregivers received < 2 support calls, the reported value for ADHD < 2.4 but ≥ 2, then caregivers were likely to return to the intervention for login (28/5).
5	If caregivers received < 2 support calls, the reported value for ADHD < 2.4 and < 2, plus oppositional behavior (ODD OPP) < 1.7 and the reported value for parental psychopathology (DASS) ≥ 0.32, then caregivers were likely to return to the intervention for login (35/7).
6	If caregivers received < 2 support calls, the reported value for ADHD < 2.4 and < 2, plus oppositional behavior (ODD OPP) < 1.7 and the reported value for parental psychopathology (DASS) < 0.32, then caregivers were, as a tendency, likely to return to the intervention for login (7/2).
7	If caregivers received < 2 support calls, the reported value for ADHD < 2.4 (and < 2), plus oppositional behavior (ODD OPP) ≥ 1.7 and ADHD was < 1.9 but parental psychopathology (DASS) ≥ 0.51, then caregivers were, as a tendency, likely to return to the intervention for login (8/3).
8	If caregivers received < 2 support calls, the reported value for ADHD was < 2.4 (and < 2), plus oppositional behavior (ODD OPP) ≥ 1.7 and ADHD < 1.9 but parental psychopathology (DASS) < 0.51, then the relation of caregivers that did not return to the intervention for login changed, resulting in a tendency towards a higher risk of not returning (8/3).

9	If caregivers received < 2 support calls, the reported value for ADHD < 2.4 (and < 2), plus oppositional behavior (ODD OPP) ≥ 1.7 and ADHD ≥ 1.9 , then caregivers did not return to the intervention for login (9/0).
10	If caregivers received < 2 support calls, the reported value for ADHD ≥ 2.4 and positive parenting (PNPQ) < 3, then likelihood of returning to the intervention was almost 50% (3/2).
11	If caregivers received < 2 support calls, the reported value for ADHD ≥ 2.4 and positive parenting (PNPQ) ≥ 3 , then caregivers did not return to the intervention for login (13/1).

Nodes	Decision tree predicting frequency of utilization (number of logins)
1	If number of support calls ≥ 2 , the reported value for ADHD skills and reflectivity < 1, parental psychopathology (DASS) ≥ 0.6 , and caregiver's age ≥ 50 , then number of logins is at maximum (13).
2	If number of support calls ≥ 2 and ADHD skills and reflectivity < 1 and DASS ≥ 0.6 and caregiver's age < 50 and the child's gender is female, then number of logins is 12.
3	If number of support calls ≥ 2 and ADHD skills and reflectivity < 1 and DASS ≥ 0.6 and caregiver's age < 50 and the child's gender is male, then number of logins is 7.
4	If number of support calls ≥ 2 and ADHD skills and reflectivity < 1 and DASS < 0.6, then number of logins is 6.
4	If number of support calls ≥ 2 and ADHD skills and reflectivity ≥ 1 , then number of logins is 4.
5	If number of support calls is < 2, oppositional behavior (ODD OPP) < 2, caregivers reported being married/ in partnership with afternoon care for the child(ren), caregiver's age ≥ 39 and ADHD symptomatology ≥ 2 , then number of logins is 11.
6	If number of support calls is < 2, oppositional behavior (ODD OPP) < 2, caregivers reported being married/ in partnership <u>with</u> afternoon care for the child(ren), caregiver's age ≥ 39 and ADHD symptomatology < 2, then number of logins is 6.
7	If number of support calls is < 2, oppositional behavior (ODD OPP) < 2, caregivers reported being married/ in partnership <u>without</u> afternoon care for the child(ren), child has never received occupational therapy, and positive parenting skills < 3, then number of logins is 9.
8	If number of support calls is < 2, oppositional behavior (ODD OPP) < 2, caregivers reported being married/ in partnership <u>without</u> afternoon care for the child(ren), child has never received occupational therapy, and positive parenting skills ≥ 3 , then number of logins is 3.
9	If number of support calls is < 2, oppositional behavior (ODD OPP) < 2, caregivers reported being married/ in partnership <u>without</u> afternoon care for the child(ren) and the child receives occupational therapy (current or past), then number of logins is 3.
10	If number of support calls is < 2, oppositional behavior (ODD OPP) < 2, caregivers reported being married/ in partnership <u>without</u> afternoon care for the child(ren), child has never received occupational therapy, and positive parenting skills ≥ 3 , then number of logins is 3.
11	If number of support calls is < 2, oppositional behavior (ODD OPP) < 2 but caregiver reported not being married / in partnership, then number of logins is 2.
12	If number of support calls is < 2, oppositional behavior (ODD OPP) ≥ 2 , and caregiver reported < 4 people in their household, then number of logins is 5.

13	If number of support calls is < 2, oppositional behavior (ODD OPP) ≥ 2 and caregiver reported ≥ 4 people in their household, then number of logins is at minimum (1).
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Nodes	Decision rules for the prediction of intensity of utilization (%)
1	If caregivers received all six support calls, had been referred to the study by their pediatrician, and reported ODD impairment ≥ 1.3 , then maximum progress was processed (59%).
2	If caregivers received all six support calls, had been referred to the study by their pediatrician, and reported ODD impairment < 1.3, then 39% was processed.
3	If caregivers received all six support calls, had been referred to the study by their child and youth psychiatrist, then 36% progress was processed.
4	If caregivers received less than six support calls and caregiver's age ≥ 47 , then 38% progress was processed.
5	If caregivers received less than six support calls and caregiver's age < 47, caregivers reported high educational attainment, and ADHD symptomatology of the child < 2.3 plus ADHD impairment ≥ 1.7 , then 52% progress was processed.
6	If caregivers received less than six support calls and caregiver's age < 47, caregivers reported high educational attainment, and ADHD symptomatology of the child < 2.3 plus ADHD impairment < 1.7, then 27% progress was processed.
7	If caregivers received less than six support calls and caregiver's age < 47, caregivers reported high educational attainment, and ADHD symptomatology of the child ≥ 2.3 , then 11% progress was processed.
8	If caregivers received less than six support calls and caregiver's age < 47, caregivers reported low to intermediate educational attainment, and ADHD skills and reflectivity < 0.92, prosocial behavior (ODD PBS) of the child ≥ 1.4 , and positive parenting skills < 3.1, then 35% progress was processed.
9	If caregivers received less than six support calls and caregiver's age < 47, caregivers reported low to intermediate educational attainment, and ADHD skills and reflectivity < 0.92, prosocial behavior (ODD PBS) of the child ≥ 1.4 and positive parenting skills ≥ 3.1 , then 18% progress was processed.
10	If caregivers received less than six support calls and caregiver's age < 47, caregivers reported low to intermediate educational attainment, and ADHD skills and reflectivity < 0.92, prosocial behavior (ODD PBS) of the child < 1.4, then 8.4% progress was processed.
11	If caregivers received less than six support calls and caregiver's age < 47, caregivers reported low to intermediate educational attainment, and ADHD skills and reflectivity ≥ 0.92 , then 11% progress was processed.

5.2 Additional Files: The Relationship Between Symptom Change and Use of a Web-Based Self-Help Intervention for Parents of Children With Externalizing Behavior Disorders: Exploratory Study

Supporting Material for *The Relationship Between Symptom Change and Use of a Web-Based Self-Help Intervention for Parents of Children With Externalizing Behavior Disorders: Exploratory Study* by Wähnke et al. in press 2024

Table S1. Parameters for main analyses: associations of child externalizing symptoms (clinician- and caregiver-rated) and number of logins to the intervention

Model	Path	β	SE	p
A: Clinician-rated				
	Child externalizing symptoms at T1 → child externalizing symptoms at T2	0.62*	0.04	< .001
	Child externalizing symptoms at T2 → child externalizing symptoms at T3	0.76*	0.03	< .001
	Logins T1-T2 → logins T2-T3	0.24*	0.06	< .001
	Child externalizing symptoms at T1 → logins T1-T2	0.08	0.06	.176
	Logins T1-T2 → child externalizing symptoms at T2	-0.07	0.05	.158
	Logins T1-T2 → child externalizing symptoms at T3	-0.04	0.05	.437
	Child externalizing symptoms at T2 → logins T2-T3	0.04	0.06	.467
	Logins T2-T3 → child externalizing symptoms at T3	0.07	0.04	.101
B: Caregiver-rated				
	Child externalizing symptoms at T1 → child externalizing symptoms at T2	0.69*	0.04	< .001
	Child externalizing symptoms at T2 → child externalizing symptoms at T3	0.72*	0.04	< .001
	Logins T1-T2 → logins T2-T3	0.23*	0.06	< .001
	Child externalizing symptoms at T1 → logins T1-T2	-0.01	0.06	.919
	Logins T1-T2 → child externalizing symptoms at T2	0.02	0.06	.687
	Logins T1-T2 → child externalizing symptoms at T3	-0.13*	0.06	.029
	Child externalizing symptoms at T2 → logins T2-T3	0.14*	0.06	.029
	Logins T2-T3 → child externalizing symptoms at T3	0.06	0.05	.157

Note. A-B=model reference according to Figure 2 and with reference to Table S2, T1=pre-treatment (baseline), T2=3 months after baseline, T3=6 months after baseline; T1-T2=number of logins months 0 to 3, T2-T3=number of logins months 3 to 6; *p<.05.

Table S2. Model fit for all path models calculated on the association of use with the child’s overall externalizing symptoms

Model & Path	χ^2			CFI	SRMR
	χ^2	<i>df</i>	<i>p</i>		
A: Clinician-rated child externalizing symptoms and number of logins	11.81	2	0.00	0.97	0.026
B: Caregiver-rated child externalizing symptoms and number of logins	24.30	2	0.00	0.92	0.038
a: Clinician-rated child externalizing symptoms and percentage of completed tasks/videos (%)	15.17	2	0.00	0.96	0.030
b: Caregiver-rated child externalizing symptoms and percentage of completed tasks/videos (%)	25.63	2	0.00	0.90	0.039

Note. A-B=model reference according to Figure 2 and Table S1, a-b=model reference according to Table S3; **p*<.05.

Table S3. Parameters for secondary analyses: associations of child externalizing symptoms (clinician- and caregiver-rated) and the percentage of completed material (%)

Model	Path	β	SE	p
a: Clinician-rated				
	Child externalizing symptoms at T1 → child externalizing symptoms at T2	0.63*	0.04	< .001
	Child externalizing symptoms at T2 → child externalizing symptoms at T3	0.76*	0.03	< .001
	Completed material T1-T2 → completed material T2-T3	0.05	0.06	.405
	Child externalizing symptoms at T1 → completed material T1-T2	0.08	0.06	.181
	Completed material T1-T2 → child externalizing symptoms at T2	-0.09	0.05	.084
	Completed material T1-T2 → child externalizing symptoms at T3	-0.01	0.05	.843
	Child externalizing symptoms at T2 → completed material T2-T3	-0.04	0.06	.056
	Completed material T2-T3 → child externalizing symptoms at T3	0.01	0.04	.889
b: Caregiver-rated				
	Child externalizing symptoms at T1 → child externalizing symptoms at T2	0.68*	0.04	< .001
	Child externalizing symptoms at T2 → child externalizing symptoms at T3	0.46*	0.07	< .001
	Completed material T1-T2 → completed material T2-T3	0.04	0.06	.519
	Child externalizing symptoms at T1 → completed material T1-T2	0.03	0.06	.574
	Completed material T1-T2 → child externalizing symptoms at T2	-0.09	0.06	.104
	Completed material T1-T2 → child externalizing symptoms at T3	0.01	0.06	.828
	Child externalizing symptoms at T2 → completed material T2-T3	-0.12	0.09	.202
	Completed material T2-T3 → child externalizing symptoms at T3	-0.05	0.05	.249

Note. a-b=model reference to Table S2, T1=pre-treatment (baseline), T2=3 months after baseline, T3=6 months of baseline; T1-T2=completed material (task/videos) in % between T1 and T2 (month 0-3), T2-T3=completed material (task/videos) in % between T2 and T3 (months 3-6); *p<.05.

Table S4. Description of usage parameters (early and late)

Variable	Early Use (T1T2)				Late Use (T2T3)				<i>p</i> ¹
	<i>M</i>	<i>SD</i>	min	max	<i>M</i>	<i>SD</i>	min	max	
Login (n)	5	4.38	0	18	0.53	1.20	0	9	<.001
Progress (%)	31.88	26.08	0	96.70	1.93	5.83	0	31.72	<.001

Note. *N*=276. ¹ Mean comparisons were made using t-tests for dependent samples.

5.3 Declaration

Hiermit versichere ich an Eides statt, dass ich die vorliegende Dissertationsschrift selbstständig und ohne die Benutzung anderer als der angegebenen Hilfsmittel angefertigt habe. Alle Stellen - einschließlich Tabellen, Karten und Abbildungen -, die wörtlich oder sinngemäß aus veröffentlichten und nicht veröffentlichten anderen Werken im Wortlaut oder dem Sinn nach entnommen sind, sind in jedem Einzelfall als Entlehnung kenntlich gemacht. Ich versichere an Eides statt, dass diese Dissertationsschrift noch keiner anderen Fakultät oder Universität zur Prüfung vorgelegen hat; dass sie - abgesehen von unten angegebenen Teilpublikationen - noch nicht veröffentlicht worden ist sowie, dass ich eine solche Veröffentlichung vor Abschluss der Promotion nicht ohne Genehmigung der / des Vorsitzenden des IPHS-Promotionsausschusses vornehmen werde. Die Bestimmungen dieser Ordnung sind mir bekannt. Die von mir vorgelegte Dissertation ist von Univ.-Prof. a.D. Dr. Manfred Döpfner betreut worden.

Darüber hinaus erkläre ich hiermit, dass ich die Ordnung zur Sicherung guter wissenschaftlicher Praxis und zum Umgang mit wissenschaftlichem Fehlverhalten der Universität zu Köln gelesen und sie bei der Durchführung der Dissertation beachtet habe, und verpflichte mich hiermit, die dort genannten Vorgaben bei allen wissenschaftlichen Tätigkeiten zu beachten und umzusetzen.

Übersicht der Publikationen:

Wähnke, L., Dose, C., Klemp, M.-T., Mühlenmeister, J., Plück, J., Döpfner, M. (in press, 2024). The Relationship Between Symptom Change and Use of a Web-Based Self-Help Intervention for Parents of Children With Externalizing Behavior Disorders: Exploratory Study. *JMIR Pediatrics and Parenting*. 11/07/2024:54051, DOI: 10.2196/54051

Wähnke, L., Plück, J., Bodden, M., Ernst, A., Klemp, M. T., Mühlenmeister, J., & Döpfner, M. (2024). Acceptance and utilization of web-based self-help for caregivers of children with externalizing disorders. *Child and Adolescent Psychiatry and Mental Health*, 18(1), 40

Ich versichere, dass ich alle Angaben wahrheitsgemäß nach bestem Wissen und Gewissen gemacht habe und verpflichte mich, jedmögliche, die obigen Angaben betreffenden Veränderungen dem IPHS-Promotionsausschuss unverzüglich mitzuteilen.

Die dieser Arbeit zugrundeliegenden Daten wurden im Rahmen des Innovationsfonds (Gemeinsamer Bundesausschuss) geförderten Drittmittelprojektes „WASH – Evaluation eines web-assistierten Selbsthilfe-Trainings für Eltern von Kindern mit Aufmerksamkeitsdefizit- / Hyperaktivitätsstörung“ am Ausbildungsinstitut für Kinder- und Jugendlichenpsychotherapie (AKiP) an der Uniklinik Köln und der Klinik und Poliklinik für Psychiatrie, Psychosomatik und Psychotherapie des Kindes- und Jugendalters der Universität zu Köln erhoben (ID: VF1_2016–058).

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27.12.2024

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Datum

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Laura Wähnke

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