The Relationship between Symptom Change and Utilization of a Web-Based Self-Help Intervention for Parents of Children with Externalizing Disorders

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Abstract

Background: Web-based self-help parent management trainings have widely been implemented in the evidence based treatment of children with behavioral problems. However, little is known about the direct association of caregiver usage and child externalizing symptom changes.

Objective: This study aims to examine the association between the utilization of web-based self-help (WASH) for caregivers and their children's externalizing symptoms.

Methods: Longitudinal data of 276 families from two intervention conditions of a randomized controlled trial (either unguided or supported by a therapist via telephone) were analyzed. Child symptoms of attention-deficit/hyperactivity disorder (ADHD) and oppositional defiant disorder (ODD) were assessed before (T1), during (T2), and after the 6-month WASH intervention (T3). Additionally, two indicators of caregivers' utilization of the WASH intervention were considered: number of logins and completed tasks/videos (%). Associations of caregivers' utilization during early (T1-T2) and late treatment (T2-T3) with child externalizing symptoms were analyzed using path analyses (structural equation modeling).

Results: Frequency and intensity of use were higher at T1-T2 than at T2-T3. The intensity of use at early treatment (T1-T2) was significantly associated with ADHD symptoms at T2 (but not at T3), and the frequency of use during early treatment (T1-T2) was significantly associated with ODD symptom severity at T3 (but not at T2). Moreover, child ADHD severity at T2 predicted number of caregiver logins in the following period (T2-T3).

Conclusions: The findings underline the importance of the frequency and intensity of use in order to achieve symptom improvements during WASH. The lack of significant associations between utilization in the later treatment period and subsequent symptom severity might be attributable to a generally low utilization in this treatment period.

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The Relationship between Symptom Change and Utilization of a Web-Based Self-Help Intervention for Parents of Children with Externalizing Disorders

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Abstract

Background: Web-based self-help has been found to be effective in the treatment of child externalizing disorders. However, research on the associations of caregiver utilization and symptom changes of child externalizing behaviors is lacking. **Objectives:** The present study examined the longitudinal and reciprocal associations between the utilization of web-based self-help (WASH) for caregivers of children with externalizing disorders and their children's externalizing symptoms. **Methods:** Longitudinal data of 276 families from two intervention conditions of a randomized controlled trial (either unguided or supported by a therapist via telephone) were analyzed. Caregiver- and clinician-rated child externalizing symptoms were assessed before (T1), in the middle (T2), and after the 6-month WASH intervention (T3). Additionally, two indicators of the caregivers' utilization of the WASH intervention were considered: number of logins (frequency) and the percentage of completed material (intensity). Associations of caregivers' utilization during early (T1-T2) and late treatment (T2-T3) with child externalizing symptoms were analyzed using path analyses (structural equation modeling). **Results:** Frequency and intensity of use were higher during the first three months than during the second three months of the intervention period. The number of logins at early treatment was significantly, but weakly associated with caregiver-reported externalizing symptoms in the long term (T3). Moreover, caregiver-reported child externalizing severity at T2 predicted the number of logins in the late treatment. The results were not replicated when considering the percentage of completed material as measure of utilization or when considering clinician ratings of child externalizing symptoms. **Conclusion:** The findings provide first, albeit weak evidence for longitudinal associations between caregiver utilization of WASH and improvements in caregiver-rated child externalizing symptoms. However, as the associations were rather weak and could not be replicated across different rater perspectives and operationalizations of utilization, further research is needed to better understand these relations and their interplay with other putative influence factors (e.g., quality of the implementation of the interventions, changes in parenting behaviors).

Keywords: web-based self-help, e-health, parent management training, externalizing symptoms, ADHD

Background

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 disorders (ADHD) [3]. Although previous research has demonstrated both self-directed and face-to-face PMT to be effective in reducing child externalizing disorders, outcome ratings of PMT vary across different assessors (e.g. parents, clinicians, objective observations), with stronger evidence for PMT in caregiver reports [4, 5]. Improvements were reported by the caregiver (completer) for conduct problems ($p = 0.001$) as well as hyperactivity symptoms ($p < 0.001$) [6]. Moreover, it remains unclear what drives symptom-related improvements: While some studies indicate that parental attendance and engagement in face-to-face parent training 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 parent training [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 symptoms [8]. Additionally, parental outcomes (e.g., warm interactions, and reduced physical punishment) seem to be associated with quality of participation (rated by a therapist, e.g. completion of between-session homework or amount of participation in the group) rather than with mere attendance in parent training 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, e.g., externalizing behavior disorders [10, 11] as well as anxiety disorders [12]. There is evidence for the efficacy of web-based PMT regarding the reduction of 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 three-arm randomized controlled trial (RCT), we demonstrated that web-assisted self-help (WASH) combined with therapist telephone support was superior to routine clinical care as well as WASH alone in reducing clinician-rated child externalizing symptoms [21, 22]. 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 [23].

Considering self-directed interventions based on booklets for caregivers of children with externalizing behavior (e.g., booklets), parental adherence is associated with improved externalizing child behavior [24]. Research on attrition and usage provides indications that more frequent users of e-health reported a decline in their perceived burden compared with an increased perceived burden reported by nonusers [25]. Regarding web-based PMT for caregivers of children with anxiety and depressive symptoms, parental engagement (defined as stronger orientation towards recommended use, i.e. task completion) predicted (caregiver-rated) preventive parenting and lower impairment in child quality of life [26]. However, parental engagement did not predict changes in internalizing symptoms (caregiver- and child-reported). 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, the child's severity of externalizing behavior at baseline for the intervention on which this research is based has previously been found to be one of the predictors for the use of WASH [23]. There is evidence that parental perception of the severity of child symptoms is predictive of their help-seeking behaviors [27]. However, factors that are associated with parental engagement in children's mental health treatment have yielded divergent results, with some research indicating, e.g., child mental health symptoms as a predictor for parental engagement and others not [8, 28].

Clearly, the actual use of web-based interventions is a prerequisite for their efficacy. To date,

there is no common sense of how utilization of web-based interventions is conceptualized and operationalized, with measures ranging from direct measures (i.e. self-report) to objective measures (i.e. automatic data tracking of e.g. the number of logins) [29]. 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 (e.g., practically adapting parenting behaviors) [28]. In a systematic review, the most commonly reported measure for adherence is the number of logins to e-therapies [30]. However, a unidimensional operationalizing of the term utilization has been criticized by researchers [31, 32], 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 [23, 28].

To our knowledge, no study on web-based PMT for child externalizing behaviors has analyzed the relations between parental utilization and changes in child externalizing 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 (e.g. preventive program, booklet self-help, face-to-face group PMT), the target group (affected individuals, mostly adults, vs. parents), the operationalization of treatment utilization, outcome measures, and how outcome measures are assessed. In behavioral face-to-face PMT, research on the association between attendance and child symptom severity has yielded divergent results [8, 28].

The present study took an exploratory approach to examine the longitudinal and reciprocal associations between the utilization of WASH and child externalizing symptom severity, using three subsequent assessment points of child externalizing symptoms and in-between assessments of WASH utilizations. Although it might seem self-evident that the actual use of an intervention is a prerequisite for it to affect child symptoms, previous research has yielded mixed findings in this

regard [8, 28]. Thus, we did not formulate specific a-priori hypotheses for possible associations. Moreover, as a previous study using baseline data of the same dataset as the current study demonstrated the predictive value of baseline symptom severity for the subsequent use of WASH [23], we also exploratively examined longitudinal associations between previous symptom severity and subsequent utilization. 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 symptoms to get a more comprehensive impression of their associations with utilization. Moreover, as it has been criticized that previous research often considered only one possible measure of utilization, we considered both the number of logins (frequency of use) and the percentage of completed materials (intensity of use) to operationalize utilization. However, we chose to consider the number of logins for our primary analyses, as this is the measure most often used in previous research [30]. The current research is based on the utilization of web-based self-help PMT in terms of automatically tracked objective measures (number of logins, percentage of processed content) of using an online treatment, in which caregivers are free to take an interest-based approach in processing the training [23]. Findings for associations between the percentage of completed materials and child externalizing 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 effective therapeutic supply for children with externalizing behavior disorders.

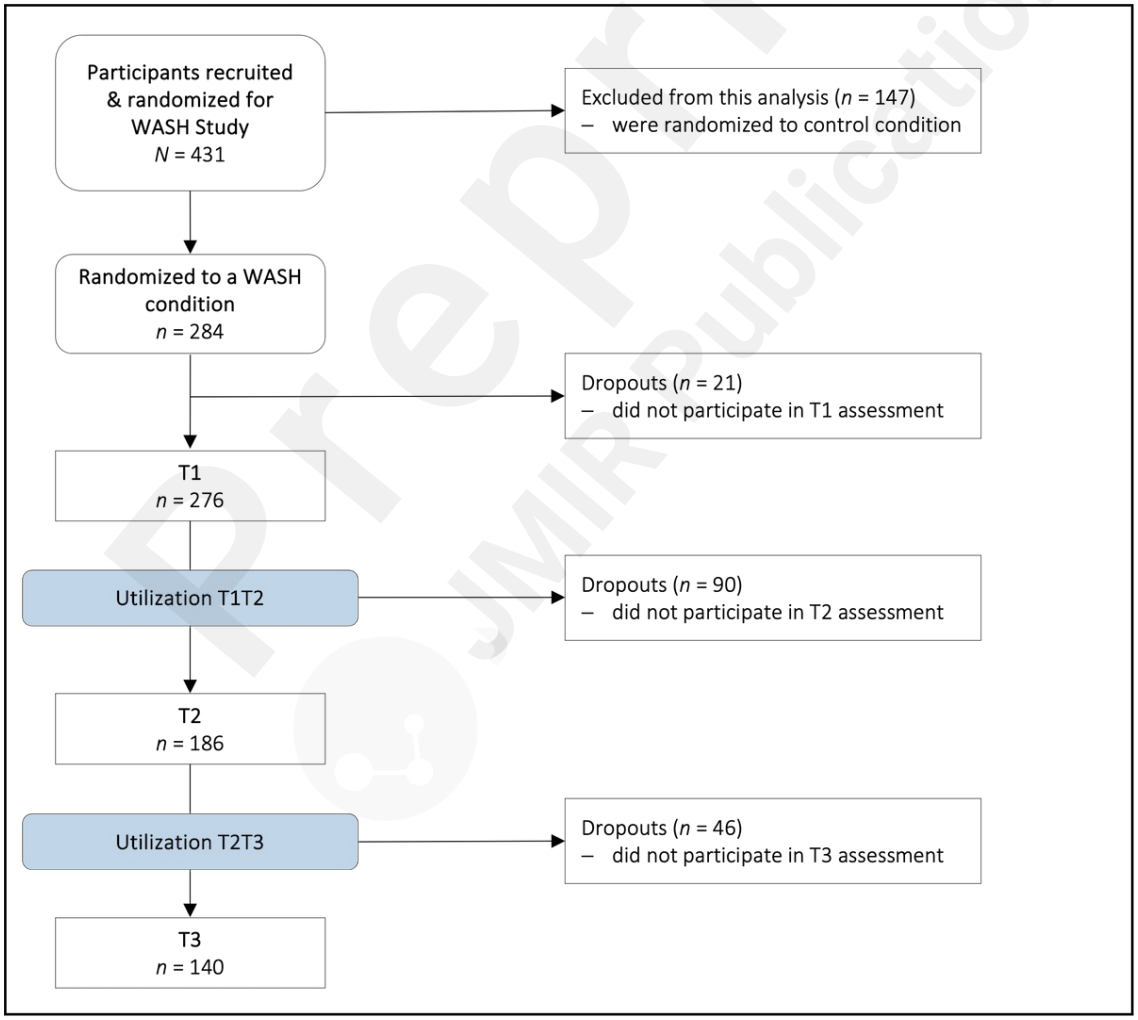
Methods

Study Design

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

Participants

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



Note: WASH Study = German RCT study to evaluate web-assisted self-help, Utilization=utilization of treatment

Figure 1. Participant flow

Intervention

The online intervention was based on previous manual-based self-help programs that have proven effective in reducing children's ADHD or oppositional defiant disorder (ODD) symptoms [33-35]. The WASH intervention comprises four 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 (2) WASH+SUPPORT intervention received up to six 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 five days after randomization. Users in the intervention group (1) WASH 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 behavior as rated by a blinded clinician [22], the superiority of WASH+SUPPORT 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 semi-structured, telephone-based caregiver interview by a trained clinician and caregiver-rated online questionnaires before the intervention (T1), at a three-month interim assessment point during the intervention (T2), and after the intervention (i.e., at six months; T3).

Child externalizing symptoms. At each assessment point, a clinician rated the child's externalizing symptoms based on a semi-structured interview with the participating caregiver (Diagnostic Checklist for Externalizing Behavior Disorders, DCL-EXT), conducted by telephone [36]. The interview covers ADHD symptoms (18 items) and ODD symptoms (8 items) according to ICD-10 and DSM-5 and has been proven to be a high-quality diagnostic instrument for externalizing disorders [37]. For the current analyses, an overall externalizing symptoms score was calculated by

averaging all item scores. In the present sample, the internal consistency of this score was satisfactory (α = .79).

Corresponding to the clinician ratings, at each assessment point, caregivers rated their children's externalizing symptoms using 18 items of the German Symptom Checklist for ADHD and eight items of the ODD subscale of the Symptom Checklist for Disruptive Behavior Disorders [36]. The items were answered on a four-point Likert scale (ranging from 0 = *not at all* to 3 = *very much/particularly severe*) [36]. Again, a total externalizing symptoms score (SCL-EXT) was computed by averaging all item scores. The instruments have demonstrated factorial validity and satisfactory internal consistency [36, 38, 39]. Internal consistency in the present sample was Cronbach's α = .90 for the combined total SCL- EXT score.

Utilization. For each caregiver, an automatically generated log file was extracted three months after baseline (at T2) and six months after baseline (at T3), including the number of logins (i.e., *frequency of use*) in the first three months (T1-T2) and the second three months (T2-T3), respectively [40, 41]. Beyond that, we calculated the percentage of completed tasks/videos (i.e., *intensity of use, in %*) between T1 and T2 or between T2 and T3, respectively, 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 [23]. Reliability analyses for this processing progress scale yielded an acceptable internal consistency (α = .78).

Statistical Analyses

Analyses were conducted in 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 symptoms between the study conditions at T1. To examine whether child externalizing symptoms affect caregivers' utilization of the WASH intervention and vice versa, we performed path analyses. In these analyses, we considered associations between the severity of child externalizing symptoms at T1 and the caregivers'

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

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

We report standardized parameter estimates (*ß)*. To evaluate model fit, besides χ^2, we considered the Comparative Fit Index (CFI) and the Standardized Root Mean Square Residual (SRMR). In line with current recommendations, we considered CFI values > .90 and SRMR values < .08 as acceptable [23, 42]. 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 [43]. The analyses were conducted using the Statistical Package for the Social Sciences (SPSS) version 27 (for descriptive statistics and *t*-tests) and Mplus Version 7.4 (for path analyses).

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 externalizing child symptoms (DCL-EXT: M = 1.52, SD=0.36). Likewise, caregivers reported clinically relevant externalizing child symptoms (SCL-EXT: M = 1.70, SD=0.46). An independent samples *t*-test revealed no significant differences between the two intervention conditions in caregiver-reported baseline externalizing symptoms of the child (t=1.32, df=282, p=.19). After six months (DCL-EXT T3: M=1.08, SD=0.44, SCL-EXT T3: M=1.36, SD=0.50), symptom levels were still considered as elevated, according to orienting evaluation without normative standards [36]. However, both clinician-rated (t=16.33, df=193, p<.001) and caregiver-rated (t=10.70, df=158, p<.001) externalizing symptoms declined significantly between T1 and T3.

On average, caregivers logged in to the intervention five times (SD=4.38, range 0-18) during the early treatment period (months 0-3), with significantly fewer logins (M=0.53, SD=1.20, range 0-9) during the late period (months 3-6; t=17.40, df=275, p<.001). Additionally, the percentage of completed material was significantly higher in the first (M=31.88, SD=26.08, range 0-96.70) than in the second period (M=1.93, SD=5.83, range 0-31.20; t=18.76, df=275, p<.001).

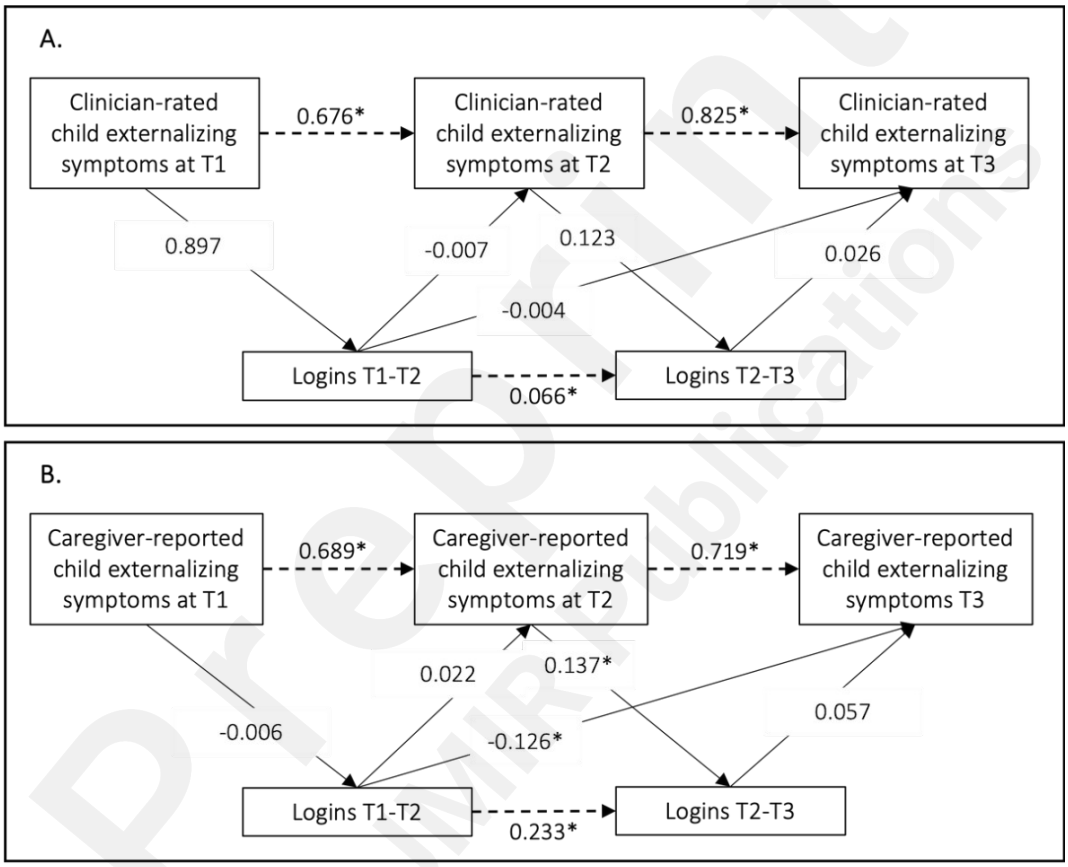
Table 1. Demographic Information on Caregiver and Child (*n*=276)

Variable	*M*	*SD*	*n*/(%) [min/max]
Caregiver			
Sex (women)			254 (92.0)
Age (years)[1]	42.93	5.95	[26.61 - 1.54]
Child			
Sex (boys)			226 (81.9)
Age (years)	9.35	1.73	[6.00 - 12.97]
ICD-10 diagnosis by local health care provider			
suspected ADHD			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 F90.9 Hyperkinetic Disorders or Hyperkinetic Disorder, Unspecified			4 (1.4)
F98.8 Attention-Deficit Disorder without Hyperactivity			6 (2.2)

Note: [1] Reduced *n=253* due to one missing value at Baseline. *M* = mean, *SD* = standard deviation. ADHD = attention-deficit/hyperactivity disorder.

Associations of Caregiver Utilization with Symptoms of the Child. Results of the path analyses on the associations between the number of logins and change in child externalizing symptom severity are reported in Figure 2 and Supplementary Table S1. The model fit was acceptable for both models (associations between clinician-rated externalizing symptoms and number of logins: CFI=.97, SRMR=.03; associations between caregiver-rated externalizing symptoms and the number of logins: CFI=.92, SRMR=.04). While significant, the Chi-square value depends strongly on the degrees of freedom, which, at df=2, were considered acceptable (see Table S2) [44, 45]. The primary analyses yielded no significant associations between the number of logins and clinician-rated externalizing child symptoms (see Figure 2 and Table S1). A small significant negative association was found between the number of logins (months 0 to 3) and the caregiver-reported externalizing symptoms in the long term (T3; *ß*=-0.13, *p*=0.29). Moreover, the caregiver-reported severity of externalizing symptoms at T2 was significantly associated with a higher number of logins in the later phase (*ß*=0.14, *p*=0.29). The significant results must be classified as small effects based on the standardized beta coefficient [46]. To examine whether the findings for the

utilization-symptom associations may be replicated when using a different operationalization of utilization, we conducted secondary analyses according to the main analyses but applied the percentage of completed materials as a measure of utilization (see Table S3). The model fit and Chi-square for both secondary models were acceptable, too (see Table S2). No significant associations were found, neither when considering clinician ratings nor when regarding caregiver ratings of child symptoms.



Note: Logins T1-T2=number of logins during early intervention phase (month 0 to 3), Logins T2-T3=number of logins during late intervention phase (month 3 to 6), Tx = measuring time; dashed line indicates autoregressive directional correlations; *p<.05.

Figure 2. Results of the path models examining the association between the caregiver's number of logins to the WASH intervention and clinician-rated (A) or caregiver-rated (B) child externalizing symptoms

Discussion

To the best of our knowledge, the present study is the first to systematically investigate the relationship between caregivers' utilization of an online intervention and change in their child's

externalizing symptoms. Overall, utilization 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 (i.e., number of logins) and changes in caregiver-reported child externalizing symptoms. That is, first, the more logins during the early phase, the less severe externalizing symptoms were reported by caregivers in the longer term. Second, on the other hand, the more severe the caregiver-rated externalizing symptoms, the more frequently caregivers logged in to the intervention in the subsequent late intervention phase (months 3 to 6). However, none of the other utilization-symptom associations in this model became significant. Moreover, we were not able to replicate these findings when we considered clinician-rated rather than caregiver-rated externalizing symptoms, nor when we operationalized caregiver utilization by the percentage of completed materials (intensity of use).

Consistent with research on the utilization of online treatment for depression, we found both more logins and higher task completion rates (frequency and intensity) in the first than in the second half of the intervention [47]. For the second intervention phase (months 3 to 6), the mean overall number of logins was very low. Furthermore, the overall progress during the six-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, 48]. 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 the present study revealed that personal telephone contact was a main predictor of enhanced utilization [23], the lack of counseling support calls (during months 3 to 6) might explain the significantly lower use in this period. The lower utilization in this period, which was additionally associated with lower variance (see Table S4), may contribute to the explanation of

the small effect sizes and the non-significant associations in the models, including clinician-rated externalizing child symptoms and/or percentage of completed materials as a measure of utilization.

Considering the present findings of at least some associations between caregivers' utilization and child symptoms, the low utilization underlines the need for measures to foster engagement in online PMT to improve intervention outcomes. Previous research demonstrated that utilization can be enhanced by some kind of support (e.g. personal contact via telephone or chat functions, reminders) [23, 49]. Contrary to previous findings of no significant utilization-symptom associations for a PMT in the field of child anxiety disorders [26], our results hint at some longitudinal associations between the number of logins to the WASH intervention and caregiver-reported child externalizing symptoms.

Notably, we not only found that (1) single aspects (frequency) of parental utilization of WASH were associated with externalizing symptoms in the longer term but also observed that (2) externalizing symptom severity during treatment predicted later frequency of use. Although the effects were rather weak, and findings varied for different (but correlated) operationalizations of utilization ($r=.73$, $p\leq.001$) [23], we consider these results as providing initial exploratory evidence of utilization-symptom associations. The different results for frequency and intensity of use underline the need for a differentiated consideration of these two parameters [31], as they capture two different facets of utilization. While the number of logins 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 logins and not for the percentage of use. Maybe the different findings might be explained by influences of child characteristics, disorder characteristics (e.g., symptom severity), or caregiver characteristics (i.e., own inattention problems), which might be related to either utilization behavior and child 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 logins 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 symptoms. Previous research on PMT aiming to compare/validate different outcome measures across different assessors (caregiver, teacher, clinician) 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 utilization (effort justification). Moreover, changes in caregivers' perceptions of the child's externalizing symptoms lead to greater tolerance, leading them to rate behavioral problems as less severe [23]. 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 symptoms is not very strong. Thus, we may conclude that simply improving the utilization 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 outcome and might be a more favorable starting point for improving interventions, e.g., emotional and behavioral problems and competencies of the parents, quality of intervention implementation. For example, internet-delivered parent training – from a theoretical and practical perspective – seems to affect parenting skills and/or parental psychopathology [12, 26], and previous research has demonstrated that the effects of parent training on child externalizing symptoms are mediated by a change in (mainly negative) parenting behaviors [50]. A deeper examination of such additional factors and their interplay is necessary to get 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 utilization 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 symptoms (e.g., parental skills practice [12], parenting behaviors), and additionally focus on the utilization of individual techniques (e.g., stimulus control, contingency management) to gain a deeper understanding of the relative contribution of treatment utilization and of the particular mechanisms which lead to symptom improvements. A combination of objective and subjective measures of the individual model components should be employed to increase the validity of the findings. Moreover, measures to enhance treatment utilization (e.g., additional support calls) and their relative importance for enhancing treatment outcomes should be examined in more detail. Recently, micro trials have examined the effectiveness of specific elements of face-to-face PMT (e.g. stimulus control techniques vs. contingency management) [51, 52]. Transferring this approach to web-based PMT and linking it to measures of treatment utilization may help to study further and explain the associations between utilization parameters and symptom changes.

Strengths and Limitations of the Study. While the present sample is larger than in many other studies, it is nevertheless small for this type of analysis, limiting the possibility of detecting significant associations [53]. 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, e.g., problem-solving strategies and contingency management into daily life were conducted. Moreover, we cannot guarantee that users engaged with the content rather than merely absolve the intervention, as we did not conduct knowledge quizzes to prove caregivers' engagement. The utilization 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 (caregiver engagement in sessions and between sessions, and parenting behaviors) to examine their contribution to symptom changes connected with caregiver utilization of WASH. On the other hand, particular strengths of the study are that we used two objective measures of utilization metrics (log data) and assessed child externalizing symptoms

from two different perspectives (i.e., caregivers and clinicians).

Conclusion

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

Ethics Approval and Declaration of Helsinki

This study was approved by the Ethics Committee of the Medical Faculty of the University Hospital Cologne (Germany) 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.

Data Availability Statement

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

Trial Registration

The randomized controlled trial from which data for the current analyses were gathered was

registered at the German Clinical Trials Register (identifier: DRKS00013456; registered on January 3rd, 2018).

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Declaration of Conflicting Interests

CD received royalties for self-help books for parents and teachers of children with ADHD published by Hogrefe. 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 report any conflicts of interest.

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Supplement

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

Model	Path		ß	*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 Supplement 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.

Supplement S2. Model fit for all path models calculated on the association of utilization with the child's overall externalizing symptoms

Model & Path	χ^2			CFI	SRMR
	χ^2	*df*	*p*		
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 Supplement S1, a-b= model reference according to Supplement S3; *p<.05.

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

Model	Path		*ß*	*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	→ 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 Supplement 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.

SYMPTOM CHANGE AND UTILIZATION OF WEB-BASED SELF-HELP

Supplement S4. Description of utilization parameters (early and late)

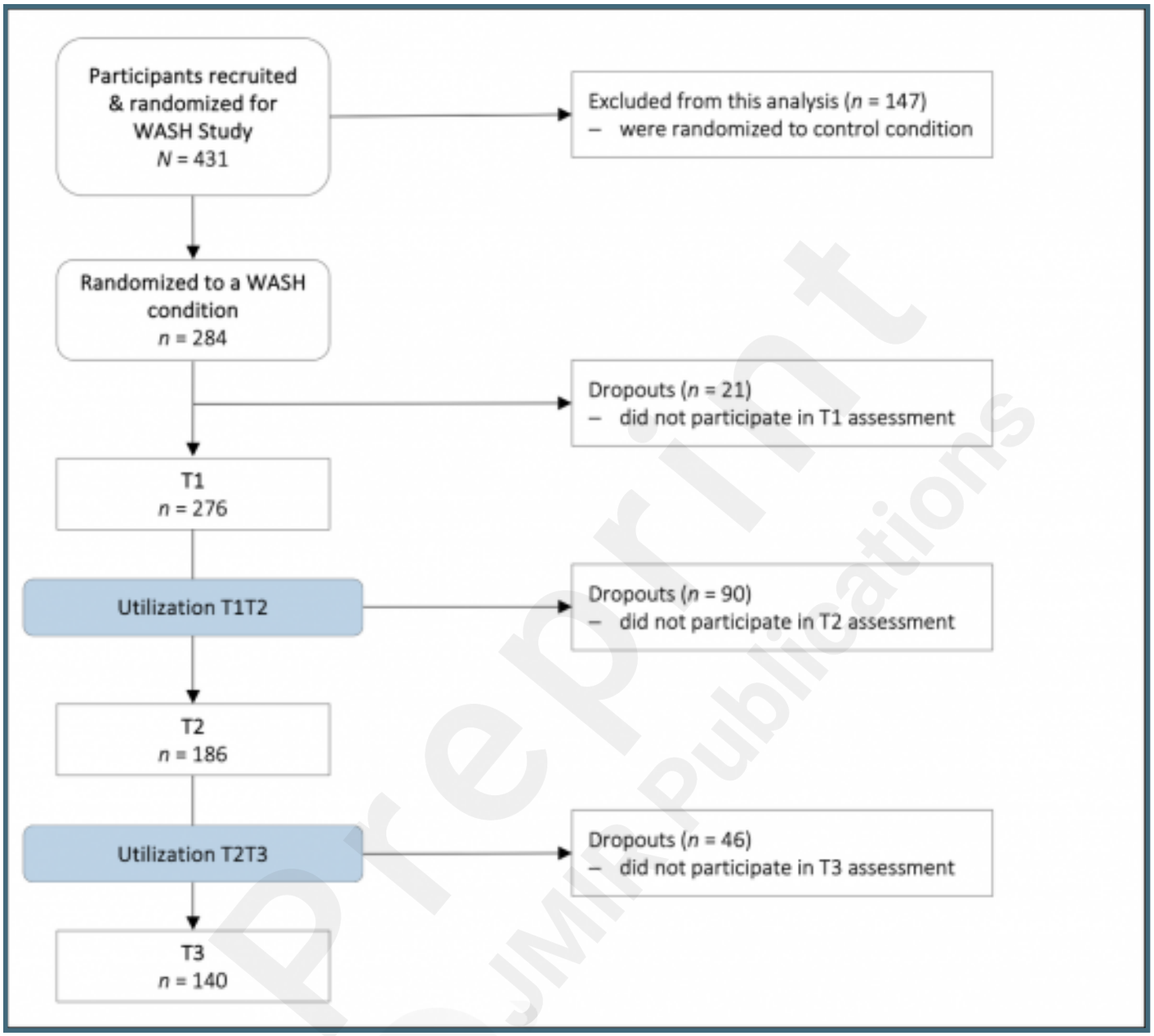
	Early Utilization (T1T2)				Late Utilization (T2T3)				
Variable	*M*	*SD*	min	max	*M*	*SD*	min	max	p^1
Login (n)	5	4.38	0	18	0.53	1.20	0	9	<.001
Progress (%)	31.88	26.08	0	96.70	1.93	5.83	0	31.72	<.001

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

Supplementary Files

Figures

Participant flow.



Results of the path models examining the association between the caregiver's number of logins to the WASH intervention and clinician-rated (A) or caregiver-rated (B) child externalizing symptoms.