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Single-Session Digital Intervention for Adolescent Depression, Anxiety and Well-being: Outcomes of a Randomized Controlled Trial with Kenyan Adolescents

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Abstract

Background: Adolescent depression and anxiety symptoms are prevalent in Sub-Saharan African countries, yet treatment options are scarce, and stigma limits help-seeking. Brief, computerized single-session interventions (SSIs) that contain empirically supported stigma-reducing elements may help expand access to treatment. We developed and evaluated such an intervention for Kenyan adolescents.

Method: High school students (*N*=103, age 13-18) were randomized to a digital SSI *Shamiri-Digital* (Shamiri means "thrive" in Kiswahili) or a study-skills control intervention. *Shamiri-Digital* consisted of reading and writing activities about three concepts: growth mindset, gratitude, and value affirmation. Both *Shamiri-Digital* and the study-skills control condition were delivered electronically in schools.

Results: Compared to the control, *Shamiri-Digital* produced greater reduction in adolescent depression symptoms in both the full sample ($p = 0.028$, $d = 0.50$) and a sub-sample of youths with moderate-to-severe depression symptoms ($p = 0.010$, $d = 0.83$) from baseline to two-week follow-up. The effects exceed the mean effects reported in meta-analyses of full-length, face-to-face psychotherapy for youth depression. There were no significant effects on anxiety symptoms, well-being, or happiness.

Conclusion: This is the first report that a brief, computerized SSI may reduce depressive symptoms in adolescents in Sub-Saharan Africa. Replication trials with extended follow-ups will help gauge the strength and durability of these effects.

Trial Registration Number: PACTR201906810558181. Pan African Clinical Trials Registry (PACTR).

Public Health Significance: This study provides evidence that a brief single-session positive-psychology intervention may help reduce depressive symptoms of adolescents living in Sub Saharan Africa, where there are few mental health professionals, and stigma limits help-seeking

Keywords: Depression, Anxiety, Adolescents, Global Mental Health, Digital Mental Health, Sub-Saharan Africa, Growth Mindset, Gratitude, Value Affirmation

Single-Session Digital Intervention for Adolescent Depression, Anxiety and Well-being: Outcomes of a Randomized Controlled Trial with Kenyan Adolescents

Adolescent depression and anxiety symptoms are prevalent worldwide (Patel & Stein, 2015), contributing an estimated 45% of the overall burden of disease in youths ages 15-19 (The Lancet, 2017). Youths in low-income environments, such as Sub-Saharan Africa (SSA), are especially vulnerable to these syndromes. In Kenya, for example, studies have found high rates of depressive and anxiety symptoms in adolescents. One study found that 43.70% of school-going youths reported elevated depressive symptoms (Ndetei et al., 2008), and another found the prevalence of elevated depressive symptoms to be 26.40% (Khasakhala, Ndetei, Mutiso, Mbwayo, & Mathai, 2012). A recent study using standardized depression and anxiety measures (Kronke & Spitzer, 2002; Kroenke et al., 2009; Spitzer et al., 2006) with school-attending adolescents in Kenya found that 45.90% exceeded established cutoffs for moderate or severe depression, and 37.99% exceeded cutoffs for moderate or severe anxiety (Osborn, Venturo-Conerly, Wasil, Schleider, & Weisz, 2019). As is often true in epidemiological research, there are cross-study differences regarding the exact prevalence of depressive and anxiety symptoms in Kenyan youths—perhaps due in part to differences in regions studied, sampling procedures, and measures used—but the studies rather consistently report substantial symptom levels. Investigators have suggested that elevated depression symptoms may reflect in part the financial and social stresses faced by low-income, low-resource families (Osborn, Venturo-Conerly et al., 2019). Others have suggested that elevated anxiety symptoms may relate in part to the pressure Kenyan students face to succeed in their schoolwork; families sacrifice to pay school fees, and a do-or-die mentality is associated with exam success, upon which further education and career opportunities hinge (e.g., Yara & Wanjohi, 2011).

Many Kenyan youths lack access to effective treatment for their mental health problems. As most evidence-based therapies are multi-session, multi-month treatments delivered by trained professionals (Weisz & Kazdin, 2017), they are not very accessible to youths in low-income countries that have few trained providers (World Health Organization, 2018). In addition, social stigma surrounding mental health problems in Kenya—e.g., seeing mental health problems as weakness, or as evidence of being bewitched by demons—inhibits help-seeking (Getanda, Papadopoulos, & Evans, 2015; Ndetei et al., 2016).

Where such barriers to mental health care exist, alternative forms of intervention may be needed. One option may be computerized interventions that can be self-administered, and with content designed to be as stigma-free as possible. Such digital self-help interventions may be particularly useful in low-resource contexts such as Kenya because they can be made readily accessible at low cost, need not require trained profeessionals (Rochlen, Zack, & Speyer, 2004), and may be designed to confer less stigma than traditional mental health services (Muñoz, 2010). Research on the efficacy of computerized interventions in reducing depression and anxiety symptoms has shown small-to-medium short-term reductions in these symptoms in general populations (Deady et al., 2017) and in youths (Andrews et al., 2018). The great majority of this work has been conducted in western countries, but new efforts are underway in non-western countries such as India (Michelson et al., 2019; Wasil et al., 2020)

Similarly, interventions that focus on positive human attibutes, instead of invoking psychopathology, may circumvent existing societal stigma around mental illness and help-seeking (Osborn, Wasil, Venturo-Conerly, Schleider & Weisz 2019; Schleider et al., 2019). Some of these interventions are referred to as “wise interventions”, interventions that focus on a single belief, skill, or concept (Walton & Wilson, 2018). Some reflect positive psychology concepts,

while some resemble core components of traditional evidence-based psychotherapies. They differ from psychotherapy, however, in their broad emphasis on adaptive human characteristics rather than on mental disorders or the treatment thereof. Some of these have been incorporated within single-session interventions (SSIs) (Schleider et al., 2019; Schleider & Weisz, 2017). One strength of SSIs is their ability to circumvent the high attrition often seen in multisession interventions (Grime, 2004), and this could make them particularly well-suited to SSA countries, where multiple sessions might be difficult logistically. There is some evidence from individual studies that brief interventions focused on positive human attributes (e.g., growth mindset) can be effective in reducing anxiety and depression symptoms (e.g., Miu & Yeager, 2015; Schleider & Weisz, 2018); meta-analytic evidence (Schleider & Weisz, 2017) has pointed to beneficial effects of SSIs on youth anxiety symptoms (g = .58), although effects on youth depression symptoms (g = .21) have been nonsignificant and require further investigation (Schleider & Weisz, 2017).

The broad concept of intervention may encompass both treatment programs for well-defined problems or disorders and prevention programs aimed at forestalling the emergence or exacerbation of problems or disorders. In fact, programs that are universal in their approach—delivered to all youths in a setting rather than solely those with elevated symptoms— may offer significant advantages. Recent research suggests that even mild subclinical symptoms of mood disorders cause distress and impairment (Ruscio, 2019), suggesting that help might be useful even to individuals at low symptom levels, not just those at clinical severity levels. Moreover, one reason individuals may not seek psychological services is to avoid being labeled as having a mental health problem; universal programs require no such labeling (Clarke, Hawkins, Murphy, & Sheeber, 1993; Corrigan, 2004; Schnyder, Panczak, Groth, & Schultze-Lutter, 2017). Evidence

on the effects of universal programs is mixed, but some studies have shown small-to-medium short-term reduction in youth depressive and anxiety symptoms (Ahlen, Lenhard, & Ghaderi, 2015; Stockings et al., 2016). Taken together, computerized self-help interventions that are delivered in a single-session and consist of stigma-reducing positive psychological content appear to warrant testing with youths in SSA countries such as Kenya, not only as treatments but also as preventive interventions.

We developed a universal, computerized self-help SSI to reduce adolescent depression and anxiety in Kenya. We adapted *Shamiri*, a three-component intervention that has previously been delivered in person, in groups, over four weeks with content that included growth mindset, gratitude, and value affirmation (Osborn, Rodriguez et al., 2019). *Shamiri* was universal, as it was administered to all students regardless of whether or not they had clinically elevated symptoms of depression or anxiety. The group-administered *Shamiri* has shown promising effects on youth depression (d = .32) and anxiety (d = .54) in Kenyan adolescents when delivered by lay counselors (Osborn, Wasil et al., 2019). Here we examined the potential of a digital self-help version of Shamiri.

Shamiri-Digital, like its live, group-administered counterpart, combines three elements from the literature on wise interventions and SSIs. Growth mindset interventions are designed to strengthen individuals' beliefs that personal characteristics can change and improve (Schleider & Weisz, 2016; Yeager, Miu, Powers, & Dweck, 2013; Yeager & Dweck, 2012; Yeager, Trzesniewski, & Dweck, 2013). Gratitude interventions are intended to promote recognition and appreciation of good things in one's life (Emmons & Stern, 2013; Froh, Kashdan, Ozimkowski, & Miller, 2009). Value affirmation interventions prompt participants to identify and reflect on their core values (Cohen, Garcia, Purdie-Vaughns, Apfel, & Brzustoski, 2009; Miyake et al.,

2010). Growth mindset interventions have been shown to improve youth depression and anxiety (Schleider & Weisz, 2018; Yeager et al., 2014), gratitude interventions have been shown to improve well-being and life satisfaction (Emmons & Stern, 2013; Froh, Kashdan, Ozimkowski, & Miller, 2009; Froh, Sefick, & Emmons, 2008), and value affirmation interventions have been shown to improve academic performance (Cohen, Garcia, Purdie-Vaughns, Apfel, & Brzustoski, 2009; Miyake et al., 2010).

In the present study, we conducted a randomized controlled trial (RCT) of *Shamiri-Digital* with Kenyan high school students. We hypothesized that adolescents assigned to *Shamiri-Digital* would experience greater reductions in depressive and anxiety symptoms, and greater improvements in overall well-being, than youths assigned to an active digitally-administred study-skills control group. Secondary goals for the present study were to: (1) gauge whether the intervention improved happiness and optimism and, (2) assess intervention impact on high-symptom adolescents who met a clinical cut-off for depression or anxiety.

Methods

Trial Design and Registration

The RCT tested effects of *Shamiri-Digital* against an active, digital study-skills control group. Participants completed assessments at baseline and two-week follow-up; a Kenyan government prohibition against non-course related activity in schools (to protect time for exam preparation and to prevent cheating) took effect two-weeks after the end of the program, ruling out a longer follow-up. The trial was pre-registered at the Pan African Clinical Trials Registry (PACTR, registration number masked) in accordance with WHO and ICMJE standards.

Study Setting

The study took place in a mixed-gender (girls > boys—see Table 1 for study gender breakdown) secondary school in Kiambu County on the outskirts of Nairobi. The private (i.e., non government-operated) boarding school admits low-income students from around Kenya and subsidizes fees (approximately $500 annually) for most students; aggregate data provided by the school administration indicates that 82 percent of the student body is on full bursary (i.e., no school fees). Such schools are an appropriate context for testing a digital intervention because most such schools in Kenya have computers with internet connection. In addition, English is an official language in Kenya and the primary language of instruction at all levels of education in Kenya; students are required to be proficient in both written and oral English prior to admission to secondary school.

Participant Recruitment and Resulting Sample

All procedures were approved by the Maseno University Ethics Review Committee (MUERC) in Kenya, prior to the start of data collection. Study recruitment took place in June 2019. The study team, comprised of student researchers from the U.S. affiliated with an American nonprofit organization as well as students from Kenyan universities, introduced and described the study as a program intended to improve wellness and academic functioning, at a school gathering with students in forms one, two, and three (grades 9-11) and offered students a chance to participate. Students aged 13 to 18 were eligible. No exclusion criteria were applied. All interested students provided either informed consent or assent (for adolescents younger than 18). Parental consent was obtained for minors through school adminstrators per MUERC guidelines. Of the 120 students informed about the study and invited to participate, we obtained

consent/assent from 103, who then participated in the study. See Figure 1 for the CONSORT flowchart and Table 1 for sample characteristics.

Measures

Depressive symptoms were assessed using the **Patient Health Questionnaire-8** (PHQ-8). The PHQ-8 is the 8-item version of the PHQ-9, a brief diagnostic and severity measure for depression, which excludes the suicidal ideation item (Kroenke & Spitzer, 2002); recent research in Kenyan schools has suggested that school administrators consider the suicidal ideation item potentially stigmatizing and alienating to students (Osborn, Venturo-Conerly et al., 2019). PHQ-8 and PHQ-9 scores are highly correlated, and the same cut-offs are used to assess severity of depressive symptoms (Kroenke & Spitzer, 2002). The PHQ-9 has been shown to have adequate internal consistency, test-retest reliability, and discriminant validity within North American samples. The PHQ-8 has also demonstrated adequate internal consistency ($\alpha = 0.73$) and discriminant validity with Kenyan adolescents (Osborn, Venturo-Conerly et al., 2019). Cronbach's alpha for the PHQ-8 in the present study was 0.73.

Anxiety symptoms were assessed using the **Generalized Anxiety Disorder Screener-7** (GAD-7). The GAD-7 has shown adequate internal consistency ($\alpha = 0.92$), convergent, diversgent, construct and criterion validity in samples of North American adolescents (Spitzer et al., 2006).The GAD-7 has also shown adequate internal consistency ($\alpha = 0.78$) and discriminant validity with Kenyan youths (Osborn, Venturo-Conerly et al., 2019). In the present study, the Cronbach alpha for the GAD-7 was 0.82.

Adolescent well-being was assessed using the shortened version of **the Warwick-Edinburgh Mental Well-being Scale** (SWEMWBS; Tennant et al., 2007). The SWEMWBS was designed to assess psychological functioning and emotional well-being. The scale consists

of seven positively worded statements, including “I’ve been dealing with problems well” and “I’ve been feeling useful.” Adequate psychometric properties, including construct, content, and criterion validity as well as internal consistency (α = 0.89) have been documented with a general population in the United Kingdom (Tennant et al., 2007) as well as in Denmark and Norway (Haver, Akerjordet, Caputi, Furunes, & Magee, 2015; Smith, Alves, Knapstad, Haug, & Aarø, 2017). To our knowledge, psychometric properties of the SWEMWBS have not been documented with Kenyan youths or those in similar countries in Sub Saharan Africa. The Cronbach’s alpha for the SWEMWBS in the present sample was 0.70.

Self-reported happiness and optimism scores were measured using the Happiness and Optimism sub-scales of the **EPOCH Measure of Adolescent Well-Being** (EPOCH) (Kern, Bensen, Steinberg, & Steinberg, 2016). The EPOCH assesses five characteristics that predict well-being, health, and similar positive outcomes in adulthood: engagement, perseverance, optimism, connectedness and happiness. The EPOCH has been validated with a community sample of Americam amd Australian adolescents (Kern et al., 2016). A recent assessment of the psychometric properties of the Happiness and Optimism subscales of the EPOCH with Kenyan youths revealed that both its optimism and happiness subscales demonstrated adequate internal consistency (α = .82 and α = .72 respectively). In the present study, Cronbach’s alpha for the Happiness subscale was 0.76. However, Cronbach’s alpha for the Optimism subscale was .69 which fell below the threshold of .70 for acceptable internal consistency (Nunnally, 1978). As a result, while we report means for the Optimism subscale in study tables, that subscale was not included in further analyses.

In a demographics questionnaire, participants reported their age, gender, and academic level. In a subsequent feedback form, participants rated—on 5-point Likert scales—the degree to

which they understood the program activities, could apply the content to their lives, and would recommend the program to Kenyan peers.

Procedures

The intervention was conducted in the computer lab of the Kenyan secondary school. As only 18 computers were connected to the internet, the intervention was conducted in groups of 18 or fewer students. At the start of each session, participants were randomly assigned to the intervention condition or study-skills condition using a random number generator embedded in the study website. The study team was thus blind to this allocation.

Participants began by reading information on the purpose of the study, the voluntary nature of participation, and the confidentiality of their responses. Afterward, participants filled out the baseline measures. Then, participants completed the intervention activities for the condition to which they were assigned. At the end of the intervention, participants filled out the feedback form and demographics questionnaire. Students were informed that they could talk to the study staff should they be distressed, and that depending on the kind and severity of the distress the staff would seek help per local customs and regulations in the school. None of the students reported such distress.

In total, participants took approximately 90 minutes to complete these steps (~30 minutes for questionnaires, ~60 minutes for intervention). Participants were given as much time as they needed to complete the activities at their own pace. Two-weeks after the intervention, participants completed study measures in their classrooms.

Intervention Arms

Shamiri-Digital Intervention. The Shamiri-Digital intervention consists of three modules: growth mindset, gratitude, and value affirmation. In the growth mindset module, participants

learned about the brain's ability to grow in response to challenges in various domains (e.g. academic, interpersonal, and personality traits). Then, participants read a growth testimonial written by a Kenyan peer. Afterward, participants wrote their own growth stories about a challenge they faced and overcame. In the gratitude module, participants learned about the importance of practicing and expressing gratitude. In a "good things" exercise, participants listed three good things in their lives for which they are grateful. In the value affirmation module, participants learned about the importance of affirming personal values (presented as "virtues" – the more common term in Kenya). Participants wrote about a time in which they used their values to guide life decisions. Adaptation of the content and exercises of the Shamiri-Digital intervention are described in detail in a manuscript reporting the efficacy of its group-based counterpart (Osborn, Wasil et al., 2019). The group-based Shamiri intervention was adapted to the present digital format via an iterative process using (a) the experience and expertise of the first author as a former Kenyan secondary school student, (b) the collective expertise of the authors in intervention design, and (c) feedback from recent Kenyan high schools graduates prior to the study. Adaptation was aimed at ensuring accessability and usability of the content and the digital format. The program included no audio or multi-media content. More information on Shamiri-Digital, and a link to the full intervention, can be found on the online supplementary materials.

Study-skills Control. The study-skills control content was similar to that of a previous study-skills control intervention that had been used in a RCT of the group-based Shamiri intervention (Osborn, Wasil et al., 2019) but was adapted to fit the digital format. It consisted of two modules: note-taking skills and effective study habits. In the first module, participants learned a step-by-step framework for note-taking. Participants then reflected on how they could

use this framework to improve their studying, and they practiced by applying the skill to a brief article. In the effective study habits module, they learned five study habits they could use to optimize time spent studying. The structure of the study-skills activities mirrored the structure of the Shamiri activities and required similar effort and time. More information can be found in the online supplementary materials.

Data Analysis Plan

We used an intent-to-treat approach and included all participants who had been randomized in our data analyses. Linear mixed models were used to compare intervention and control groups for each outcome measure. We ran four linear mixed models for our primary and secondary measures (depressive and anxiety symptoms, mental well-being, and happiness).These models were organized to reflect the hierarchical nature of the of data. All models included a random intercept that allowed for individual variation at baseline. Time, intervention condition, and their interaction were included in all models. Covariates were age in years and sex. Older adolescents are reported to face increased psychosocial stress, which may exacerbate depressive and anxiety symptoms (Osborn, Venturo-Conerly et al., 2019; Yara & Wanjohi, 2011) and gender differences in internalizing problems have been documented in Kenyan adolescents (Khasakhala et al., 2012; Ndetei et al., 2008; Osborn, Venturo-Conerly et al., 2019). Significant ($p < .05$) time * condition interactions in predicted directions would indicate that the intervention condition produced more improvement in outcomes across the study period, as compared to the control. Additionally, we calculated effect sizes (ESs) using differences in means divided by measure standard deviations; these ESs compared mean gain scores (Cohen's *d*) reflecting changes in each outcome from baseline to post-treatment for youths in the intervention versus study-skills

control intervention. Statistically significant, positive Cohen's *d* values would indicate greater improvements for intervention group youths versus control group youths.

Another secondary goal was to gauge the intervention's effect on self-reported depression and anxiety symptoms of participants who met the conventional clinical cut-off for these symptoms (as determined by a score of either >=10 on the GAD-7 or > =10 on the PHQ-8). These cutoff scores were derived from primary care studies in the United States (Kroenke et al., 2001; Kroenke, Spitzer, Williams, & Löwe, 2010) and have been used in recent studies with Kenyan youths (Osborn, Venturo-Conerly et al., 2019; Osborn, Campbell, Weisz & Ndetei 2020) We ran two linear mixed models, similar to the models for the full population described earlier, for participants who met these. ESs were also calculated.

Missing data—item level data, e.g., one question on a questionnaire— were imputed five times using the Fully Conditional Specification (FCS) methodology implemented using the multivariate imputation by chained equations (mice) algorithm in R (Buuren & Groothuis-Oudshoorn, 2011). Only 0.91% of item-level data was missing, and pre-imputation analyses revealed that data were missing completely at random.

Results

Sample Characteristics

One hundred and three adolescents aged 13-to-18, M age (SD) = 15.54 (1.22), participated in this study. There were more females (N = 66, 64.08%) than males (N = 37, 35.92%). Sample characteristics are shown in Table 1. Fifty adolescents were randomly assigned to the *Shamiri-Digital* intervention group, M age (SD) = 15.36 (1.21), and 53 to the study-skills control group, M age (SD) = 15.72 (1.21). Correlations among baseline depressive and anxiety

symptoms, as well as mental well-being, happiness and optimism, are shown the online supplementary materials. Correlations were in expected directions.

Primary Outcomes

Intervention effects on adolescent depressive symptoms. The model predicting self-reported depressive symptoms revealed nonsignificant effects for time, condition and sex, but significant effects for time * condition and the covariate age (Table 3). The significant time * condition interaction indicated that adolescents in the *Shamiri-Digital* intervention experienced larger declines in depressive symptoms from baseline to 2-week follow-up than control group youths ($p = 0.028$, $d = 0.50$ [.00, 1.6]; Table 2 and Figure 2). At baseline 56.00% of the adolescents were above cutoff for depression severity; after Shamiri, 46.00% were above cutoff. Corresponding figures for Study Skills were 52.83% and 50.94%. The significant covariate age ($p = 0.024$) indicated that younger adolescents reported larger declines in depressive symptoms from baseline to 2-week follow-up than older adolescents.

Intervention effects on adolescent anxiety symptoms. The model predicting self-reported anxiety symptoms revealed nonsignificant effects for time, condition, sex, age, and time * condition interaction (Table 3). While adolescents in the intervention experienced a decline in anxiety symptoms from baseline to 2-week follow-up compared to the control group youths, this decline was non-significant ($p = 0.280$, $d = .29$ [-.20, .79]; Table 2 and Figure 2). At baseline 48.00% of the adolescents were above cutoff for anxiety severity; after Shamiri, 40.00% were above cutoff. Corresponding figures for Study Skills were 47.17% and 37.34%.

Intervention effects on adolescent mental well-being. The model predicting self-reported mental well-being scores revealed nonsignificant effects for time, condition, sex, and time * condition, but significant effects for the covariate age. Across conditions, younger adolescents

experienced improvements in mental well-being scores from baseline to 2-week follow-up compared to the older adolescents. No difference emerged on self-reported well-being between adolescents in the intervention and control groups (see Table 2 and also the online supplementary materials).

Secondary Outcomes

*Intervention effects on adolescent happiness.*The model predicting self-reported adolescent happiness scores revealed nonsignificant effects for time, condition, sex, and time * condition, but significant effects for the covariate age. Younger adolescents experienced more improvement in their happiness scores from baseline to 2-week follow-up than older adolescents. No difference emerged on self-reported happiness between adolescents in the intervention and control groups (see Table 2 and also online supplementary materials).

Intervention effects on depressive symptoms for the subsample with elevated depressive symptoms at baseline. We conducted a sub-analysis to gauge intervention effects on the depressive symptoms of a subsample of adolescents who reported elevated depressive symptoms at baseline We used a cut-off score of >= 10 on the PHQ-8 to identify youths who endorsed moderate-to-severe depressive symptoms at baseline (Kroenke et al., 2001; Kroenke, Spitzer, Williams, & Löwe, 2010). Of 103 youths in the study, 56 youths (28 in both Shamiri-Digital and study-skills control) reported moderate-to-severe depressive symptoms at baseline. The mean baseline PHQ-8 score of youths in this sub-sample in the intervention group was 14.43 (*SD* = 3.35) while the mean score was 13.18 (*SD* = 2.89) in the control group (t = -1.49, p = 0.141). The model revealed nonsignificant effects of time, condition, sex, and age, but significant effects for time * condition. The significant time * condition interaction indicated that Shamiri-Digital youths who self-reported clinical depressive symptoms at baseline experienced greater

reductions in depressive symptoms from baseline to 2-week follow-up than similar youths in the control group (p = 0.0140, d = .83 [.31, 1.35]; Table 3 and Figure 3). To situate this effect within the broader youth psychotherapy research literature, we re-calculated the effect size for the current study using the same calculation method employed in two recent meta-analyses of youth depression psychotherapy RCTs. Those meta-analyses reported mean Hedges g=0.29 in Weisz et al. (2017, 47 youth depression RCTs) and Hedges g=0.36 in Eckshtain et al. (2019, 55 youth depression RCs). Hedges g for the clinical subsample in the present study was .44.

Intervention effects on anxiety symptoms for the subsample with elevated anxiety symptoms at baseline. We conducted another sub-group analysis to gauge intervention effects on anxiety symptoms for the subsample of adolescents who reported elevated anxiety symptoms at baseline—using a cut-off score of >= 10 on the GAD-7 to identify those youths (Spitzer, Kroenke, Williams, & Löwe, 2006). Of 103 youths in the study, 49 youths (24 in Shamiri-Digital, 25in study-skills control) reported moderate-to-severe anxiety symptoms at baseline. The mean baseline GAD-7 score of youths in this sub-sample in the intervention group was 13.33 (SD = 3.06) while the mean score was 13.40 (SD = 3.35) in the control group (t = 0.07, p = 0.940). The model revealed nonsignificant effects of condition, the covariates sex and age, and time * condition interaction, but significant effects for time. The significant time effect indicated that regardless of the group into which they were assigned, those youths who showed elevated anxiety at baseline showed declines in anxiety symptoms (p = 0.001; Table 3 and Figure 3).

Clinical significances assessed via the reliable change index. We tested whether outcomes for the full sample or the clinical subsample met the standard for clinically reliable change (Jacobsen & Truax, 1991; Wise, 2004). Reliable change thresholds were calculated using the formula $s\sqrt{(1-r)}*1.96$, using standard deviation (s) from this sample at baseline and reliability

(*r*) from published psychometric data on Kenyan adolescents for the PHQ-8 and GAD-7 (Osborn, Venturo-Conerly et al., 2019). Within the full sample, change was limited by lower mean baseline symptom levels and did not reach the reliable change threshold. However, for the clinical subsample receiving Shamiri, changes in both depression (5.97 vs. RCI 4.59) and anxiety (5.37 vs. RCI 4.77) surpassed the reliable change index; the study skills control group did not surpass the reliable change threshold for either depression (2.54) or anxiety (3.79).

Feasibility and acceptability.

Participants rated the degree to which they understood the program on a scale of 1-to-5. An independent samples *t*-test revealed high mean ratings and no significant difference in understanding of program content between the *Shamiri-Digital* (M = 4.77, SD = 0.49) and study skills (M = 4.57, SD = 0.94) groups; $t(41.91) = 1.01$, $p = 0.321$. Additionally, participants rated the degree to which they thought they could apply the lessons that they learned in the program. An independent samples *t*-test revealed high mean ratings and no significant difference in applicability scores between the *Shamiri-Digital* (M = 4.84, SD = 0.50) and study-skills (M = 4.74, SD = 0.81) groups; $t(40.17) = 0.55$, $p = 0.586$. Participants also rated whether they thought that other Kenyan adolescents would find the program useful. An independent samples *t*-test revealed high mean ratings and no significant difference in scores between the *Shamiri-Digital* (M = 4.73, SD = 0.65) and study skills (M = 4.76, SD = 0.83) groups; $t(52.12) = 1.01$, $p = 0.878$.

Discussion

We developed and tested *Shamiri-Digital,* a computerized SSI for adolescent mental health. Compared to an active study-skills control group, the *Shamiri-Digital* intervention produced significant effects on depressive symptoms in the full sample and even more substantial effects in the high-symptom sub-sample. It may be useful to consider these effects in

the context of effects found in prior meta-analyses of youth depression psychotherapy RCTs. The mean effect size found in those trials *at immediate post-treatment* was reported as Hedges g=0.29 in Weisz et al. (2017, 47 youth depression RCTs) and *g*=0.36 in Eckshtain et al. (2019, 55 youth depression RCs). When we applied the same effect size calculation method to our data that was used in those two meta-analyses, thus generating Hedges *g* values, our mean depression symptom effect size in Kenya *two weeks after the end of intervention* was *g*=.44 for the clinical sample (those above clinical cutoff at baseline—thus the group most comparable to those treated in the psychotherapy RCTs). Importantly, those previous RCTs in the meta-analyses all involved multisession, in-person psychotherapy (mean: 14 therapy sessions in Eckshtain et al, 2019)—thus, they were markedly more time-intensive and costly than single session digital Shamiri. Multi-decade comparisons of treatment effects for youth depression, anxiety, ADHD, and conduct problems and disorders have shown that treatment of youth depression generated the smallest effects (Weisz et al., 2017, 447 studies), with no improvement over time (Weisz et al., 2019, 453 studies). This suggests that new ideas may be needed in youth depression treatment. Although future tests of *Shamiri-Digital* will certainly be required to probe the robustness of the present findings, the results of this initial study do suggest that—among possible strategies for addressing youth depression symptoms—the notion of using a brief, highly scalable digital intervention that focuses on positive human qualities may warrant attention and further study.

We found non-significant *Shamiri-Digital* vs. control differences on anxiety symptoms, but with a small to medium effect (Hedges *g* .24 for full sample, .34 for the elevated symptom sample) in the predicted direction, suggesting that a larger sample might have produced significant findings. That said, many experts believe that treatments for anxiety must include guided exposures to feared stimuli in order to produce the most substantial benefits (see Weisz &

Kazdin, 2017), and effective exposures would be challenging to include in a single-session digital intervention. One other perspective on the anxiety symptom findings may warrant attention: the pattern shown in Figure 3 suggests that for youths with elevated anxiety at baseline the slope of anxiety symptom reduction associated with *Shamiri-Digital* was actually steeper than the slope of depression symptom reduction. A primary reason for the absence of a significant time * condition effect on anxiety symptoms appears to be that the study skills "control" intervention was also associated with a steep reduction in anxiety symptoms. As noted in the introduction, some experts have argued that elevated anxiety among Kenyan secondary school students can be linked in part to the high level of pressure they face to succeed in their schoolwork, in a country in which exam success or failure has massive impact on any further educational and occupational success. Our intervention was delivered prior to the third school term, when exam preparation and pressure are intense. Given this context, it is possible that our study skills intervention that was intended as a control condition actually addressed a core basis for students' anxiety, and may have thus served as an active symptom-related intervention. This suggests that a useful future direction may be testing *Shamiri-Digital* against a control condition that is less likely to reduce school-related anxiety. This hypothesis must be tempered by the fact that anxiety symptoms in the universal sample who received the study skills intervention began at a lower baseline level and did not significantly decline from baseline to follow-up; so the explanation, if it were valid for the clinically elevated sample, is likely not valid for the full universal sample.

It is interesting that, while we found improvements in depressive symptoms, we did not find significant effects of *Shamiri-Digital* on self-reported well-being or happiness. As the psychometric properties of the instruments that we used to measure these constructs have not

been extensively validated with Kenyan youths or other youths in similar Sub Saharan African countries, these findings are certainly not definitive. Future trials with different measures of these positive indicators of mental health may shed further light on whether interventions primarily targeting depressive and anxiety symptoms can produce effects on these constructs as well.

To our knowledge, the present study is the first randomized trial to investigate the efficacy of a brief digital self-help intervention with youths in Sub-Saharan Africa. As such, it is encouraging that many Kenyan youths found the intervention understandable, applicable and useful. The low barriers to scaling that the *Shamiri-Digital* intervention would provide suggest that this intervention, or perhaps others like it, may expand access to help-seeking options for many adolescents in resource-scarce environments. An important aspect of our intervention development was our effort to reduce the risk of activating stigma. It is possible that stigma may have been reduced but not eliminated entirely. In future research it would be useful to find ways to evaluate the extent to which various interventions evoke versus reduce stigma.

One limitation of the present study was that our sample size was not large enough to detect small to medium differences between conditions. Another limitation is that our study had a relatively brief follow-up period (two-weeks post-intervention). We would have preferred a longer follow-up lag time, but the timing was constrained by nationwide Kenyan regulations that prohibit all non-course-related activities during the third and final term of the academic year (August-November), to provide protected time for nationwide school examinations and to reduce the risk of cheating. For comparison, it may also be useful to note that a substantial percentage of youth depression and anxiety RCTs, most conducted in high-income Western countries, have only assessed immediate post-treatment outcomes, with no follow-up assessment (e.g., 40% in a youth depression meta-analysis by Eckshtain et al [2019], 48% in the meta-analysis by Weisz et

al. [2017]). However, the absence of follow-up, like our two-week follow-up, leaves the long-term holding power of intervention effects unknown; studies with extended follow-up assessment will be needed to address this important limitation. [This might not have been the case if students had been aware that the intervention was designed to reduce anxiety and depression symptoms, and only one condition was face valid for this outcome; but that was not the case, as students were told the intervention was designed to "improve wellness and academic functioning."] A fourth limitation is that, as noted earlier, some of the psychometric properties of the primarily Western instruments used in this study have not been well-documented for Kenyan youths. We encourage future research to adopt and use measures that meet sound criteria for appropriateness and psychometric integrity within the cultural context of the research. A fifth limitation is that our intervention was delivered on computers, which are not universally available in Kenyan schools; other platforms, such as smartphones (which could access Shamiri via the internet) or feature phones (for which Shamiri content could be adapted and accessed through Unstructured Supplementary Service Data, USSD, as done currently by e-learning providers in Kenya—see https://enezaeducation.com/), might provide expanded access. One caveat is that most Kenyan schools do not allow students to have phones on campus.

Our findings indicate that brief computerized SSIs may be a promising avenue to investigate as a way of expanding youth mental healthcare options in low-resource environments such as Sub-Saharan African countries. These findings also support the idea that interventions focused on personal strengths (rather than deficits) may be acceptable and effective with diverse youths including Kenyan adolescents (and potentially for youths in higher-resource areas, as well). We encourage future research on both of these topics as the significant gap between mental health need and mental health services calls for a wide array of response tools. Low-cost, highly

scalable interventions such as *Shamiri-Digital* may be useful additions if future research supports their effectiveness.

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Tables and Figures

Table 1

Sample characteristics at baseline

Variable	**Shamiri-Digital Intervention** (*N* = 50)	**Study-skills Control** (*N* = 53)
Age (M, SD)	15.36 (1.21)	15.72 (1.21)
Sex		
Female	35 (70.00)	31 (58.49)
Male	15 (30.00)	22 (41.51)
Symptom & wellness levels		
PHQ-8 (M, SD)	10.60 (5.37)	9.68 (4.69)
GAD-7 (M, SD)	8.98 (5.12)	8.74 (5.30)
SWEMWBS (M, SD)	25.78 (4.43)	24.79 (4.51)
EPOCH Optimism (M, SD)	15.60 (3.55)	14.89 (3.73)
EPOCH Happiness (M, SD)	13.82 (4.14)	13.02 (4.01
Form		
One	22	21
Two	13	14
Three	15	18

Note: *Test statistic used to test for significant group difference per variable of interest. PHQ-8: Patient Health Questionnaire – 8 item version. GAD-7: Generalized Anxiety Disorder – Screener. SWEMWBS: Short Warwick-Edinburgh Mental Well-Being Scale. EPOCH Optimism: Optimism sub-scale of the EPOCH Measure of Adolescent Well-being. EPOCH Happiness: Happiness sub-scale of the EPOCH Measure of Adolescent Well-being.

Table 2

Symptom reduction and well-being improvements from baseline to 2-week follow-up

Outcome variable	Shamiri-Digital Intervention Group		Study-skills Control Group		Cohen's *d*, based on mean gain score [95% CI] (Baseline to 2-week follow-up)
	Baseline (M, SD)	2-week follow-up (M, SD)	Baseline (M, SD)	2-week follow-up (M, SD)	
Primary outcomes:					
Depressive symptoms	10.60 (5.37	8.35 (4.69)	9.68 (4.75)	10.00 (4.65)	**.50** [.00, 1.06]
Anxiety symptoms	8.98 (5.12)	7.92 (4.48)	8.74 (5.30)	9.00 (4.45)	.29 [-.20, .79]
Mental well-being	25.78 (4.43)	25.58 (4.00)	24.79 (4.51)	24.77 (4.59)	-.04 [-.54, .46]
Secondary outcomes:					
Optimism	15.60 (3.55)	15.84 (3.12)	14.89 (3.73)	14.96 (3.13)	.05 [-.43 .53]
Happiness	13.82 (4.14)	14.20 (3.65)	13.02 (4.01)	14.02 (4.01)	-.16 [-.61 .29]
Effect on elevated symptoms subsample:					
Depression symptoms	14.43 (3.35)	8.46 (4.98)	13.18 (2.89)	10.64 (4.89	. **83***[.31, 1.35]
Anxiety symptoms	13.33 (3.06)	7.96 (4.35)	13.40 (3.35)	9.61 (5.31)	.39 [-.35,1.12]

Note. For depressive and anxiety symptoms, lower scores indicate better functioning. For the other outcome measures, higher scores indicate better functioning. Where applicable, Cohen's *d* values were corrected (multiplied by -1.0) such that positive values indicate greater improvements for intervention group participants versus control group participants. Significant gains are highlighted in bold.

*This effect was Hedges *g*=0.44 if calculated via the post-treatment mean comparison method used in recent youth psychotherapy meta-analyses (Eckshtain et al., 2019; Weisz et al., 2017).

Table 3

Results of mixed linear models predicting intervention effects on self-reported depression and anxiety symptoms.

	Full Sample						**Elevated symptoms sub-sample***					
	PHQ - 8			**GAD - 7**			**PHQ - 8**			**GAD - 7**		
Predictors	*B*	*SE*	*p*	*B*	*SE*	*p*	*B*	*SE*	*p*	*B*	*SE*	*p*
(Intercept)	-1.86	4.74	0.695	0.66	4.73	0.890	7.92	5.76	0.172	12.87	6.13	**0.037**
Time	0.45	0.85	0.596	0.29	0.87	0.739	-2.00	1.03	0.056	-3.80	1.07	**0.001**
Condition	1.21	0.95	0.202	0.46	0.95	0.631	1.39	1.11	0.215	-0.06	1.18	0.961
Sex (Female)	1.13	0.75	0.137	1.25	0.75	0.097	-0.55	0.99	0.578	-0.14	1.04	0.897
Age	0.69	0.30	**0.024**	0.46	0.30	0.126	0.36	0.36	0.327	0.04	0.39	0.928
Time * Condition (Intervention)	-2.70	1.22	**0.028**	-1.35	1.25	0.280	-3.82	1.46	**0.010**	-1.58	1.52	0.304

Note. *Elevated symptoms sub-sample is the sub-sample that endorsed either moderate-to-severe depressive or anxiety symptoms at baseline. With the full sample, the model predicting self-reported depressive symptoms revealed nonsignificant effects for time, condition and sex, but significant effects for time * condition while with the elevated symptom sub-sample it revealed nonsignificant effects for time, condition, sex and age but significant effects for time * condition. The model predicting self-reported anxiety symptoms revealed nonsignificant effects for time, condition, sex, age and time * condition with the full sample, but significant effects for time with the elevated symptom sub-sample. PHQ – 8: Patient Health Questionnaire, GAD-7: Generalized Anxiety Disorder – Screener.

Figures

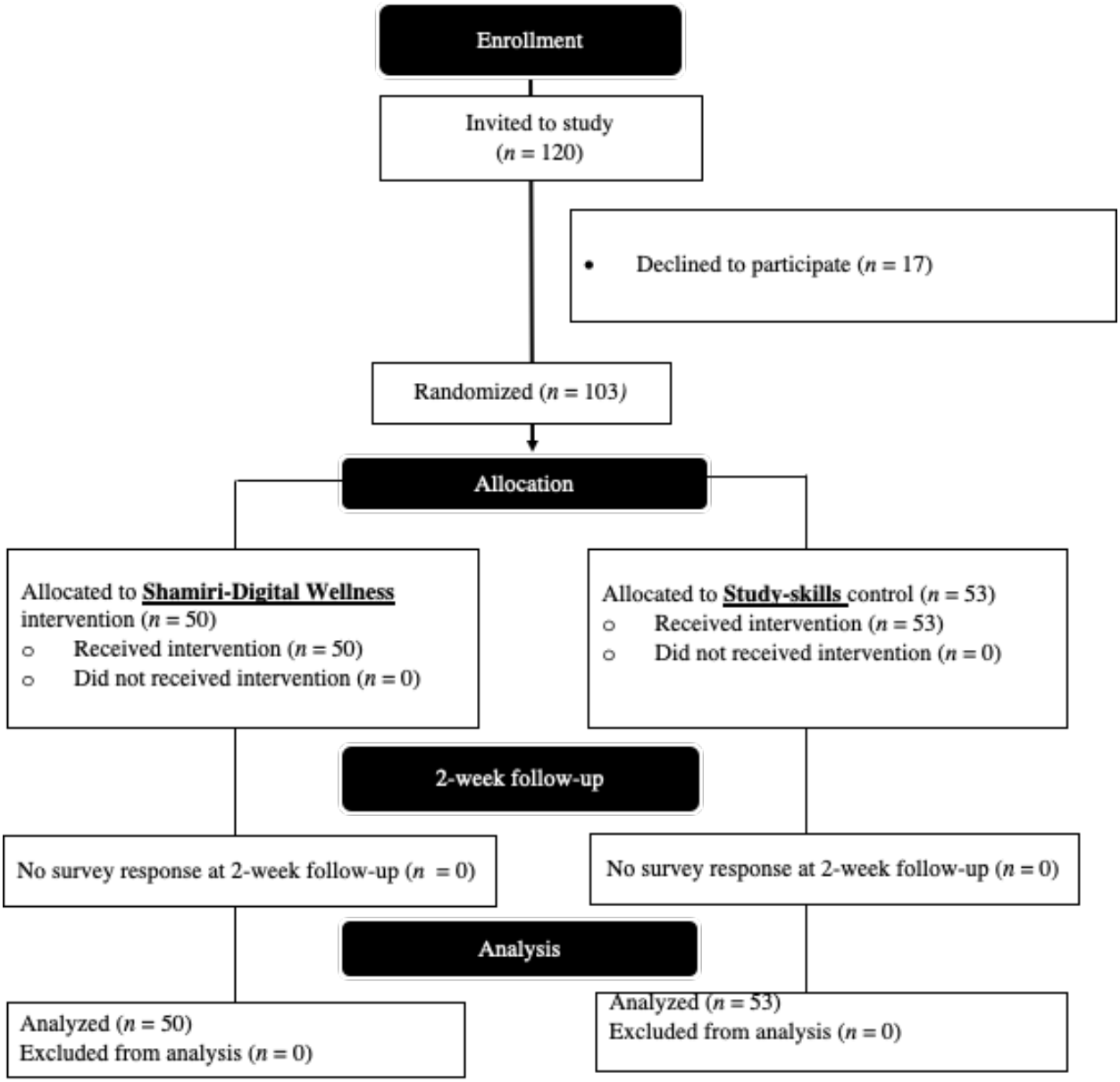

Figure 1. CONSORT diagram showing study flow.

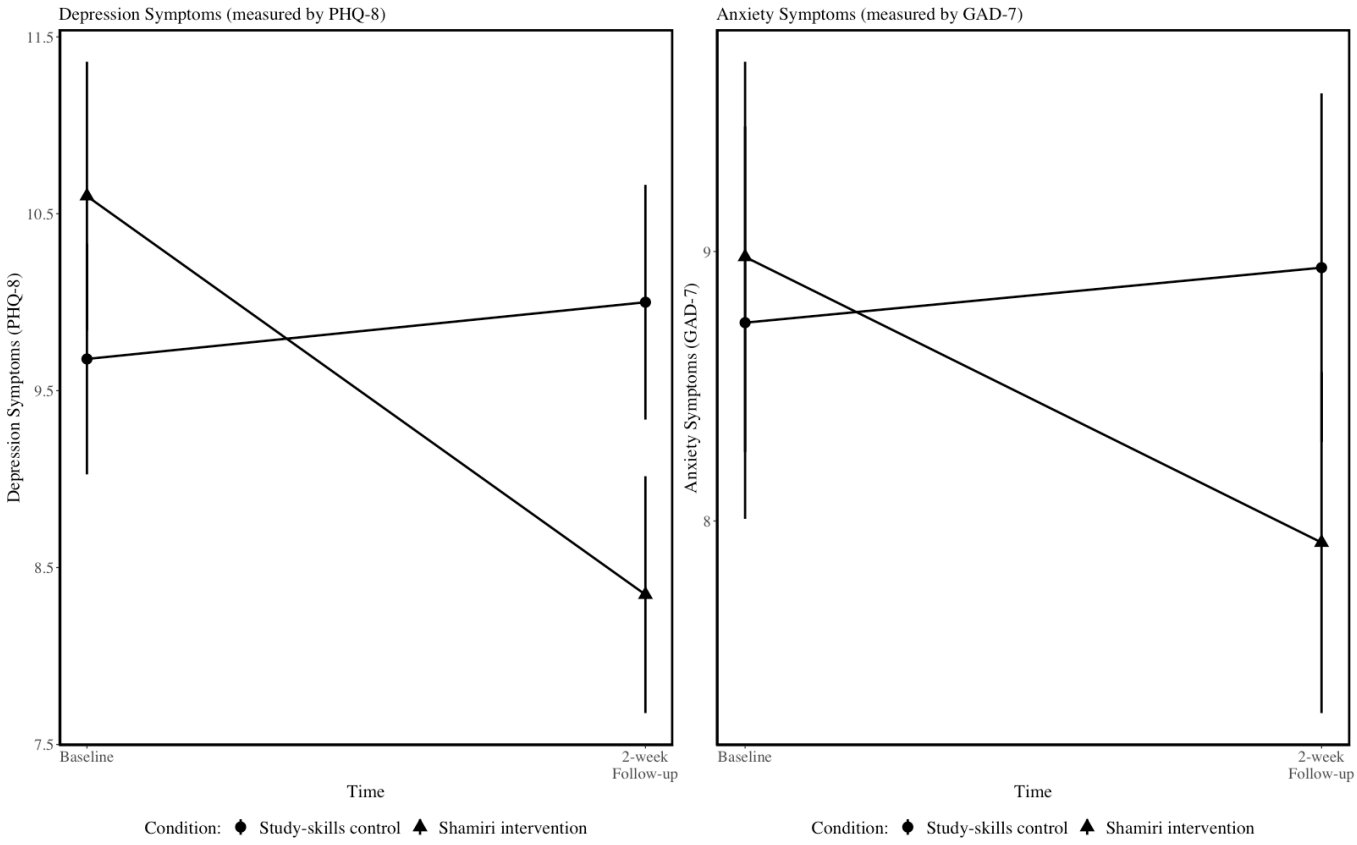

Figure 2. Fitted values showing trajectories of youth depressive and anxiety symptoms for the full sample.

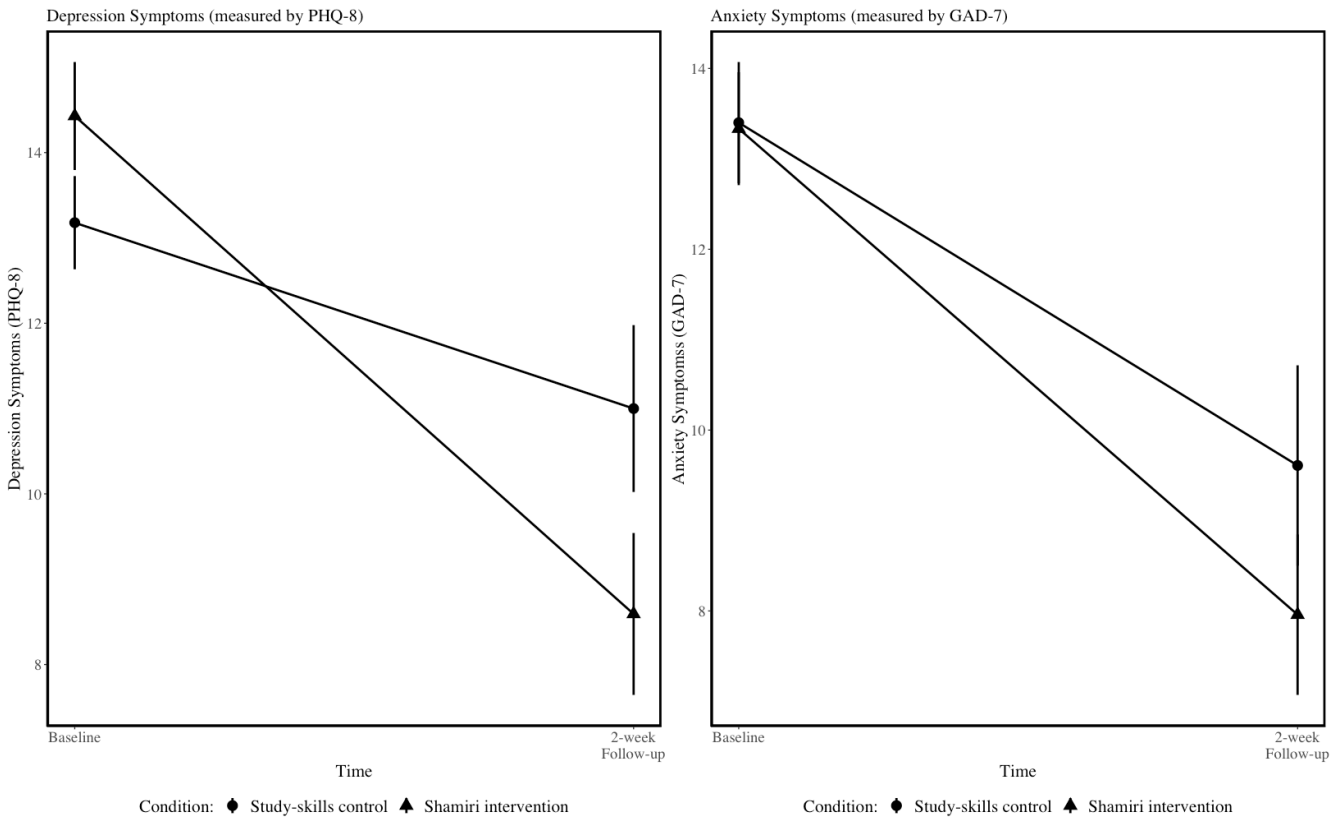

Figure 3. Fitted values showing trajectories of youth depressive and anxiety symptoms for the clinical sub-sample.