Validation of the WHO-5 Well-being Index (WHO-5) in Adolescents with Type 1 Diabetes

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ABSTRACT

OBJECTIVE It is recommended to assess the psychological status of adolescents with diabetes periodically as part of ongoing care. The WHO-Five Well-Being Index (WHO-5) is a short self-report instrument that appears suitable for this purpose. This study is the first to assess the reliability and validity of the WHO-5 in adolescents with Type 1 diabetes.

RESEARCH DESIGN AND METHODS Ninety-one adolescents with Type 1 diabetes (age 13-17) from 4 pediatric clinics completed the WHO-5, along with other psychological measures: Centre for Epidemiology Studies-Depression scale (CES-D), Diabetes Family Conflict Scale (DFCS), Mental health and Self-esteem subscales of the Child Health Questionnaire (CHQ-CF87). Confirmatory and Exploratory Factor Analyses (CFA/EFA) were conducted. Readability, homogeneity, item-total and inter-item correlations were determined. Concurrent validity was examined by calculating correlation coefficients between all measures. Sensitivity and specificity of the WHO-5 were tested against the CES-D using receiver operating characteristics (ROC) curves.

RESULTS CFA confirmed the one-factor structure; Cronbach’s α of this 5-item scale was 0.82. The WHO-5 showed a moderate to strong correlation with the CES-D (r = -0.67), Mental Health (r = 0.60) and Self-esteem (r = 0.43) subscales of the CHQ, and with the DFCS (r = -0.34), confirming concurrent validity. ROC curve analysis confirmed the WHO-5 cut-off point of < 50 for identification of mild to severe depressive affect (sensitivity 89 %, specificity 86 %).

CONCLUSIONS The WHO-5 is a brief, patient friendly measure of positive well-being with good psychometric properties that appears suitable for routine use in adolescents with Type 1 diabetes.

Abbreviations: CES-D = Center for Epidemiological Studies Depression scale, CFA = Confirmatory Factor Analysis, CHQ-CF87 = Child Health Questionnaire-Child Form 87 items, DFCS = Diabetes Family Conflict Scale, EFA = Exploratory Factor Analysis, ROC = Receiving Operator Characteristics, WHO-5 = WHO-5 well-being index
Depression appears to be two to three times more prevalent in adolescents with diabetes compared to the general population adversely affecting quality of life and diabetes outcomes (1-4). It is therefore recommended to screen for depression routinely in this age group, but there is no consensus on which measure to use for this purpose (1-3; 5). The WHO-Five Well-being Index (WHO-5) is a short, positively worded instrument designed to assess the level of emotional well-being over a 14 days period. The screening properties of the WHO-5 have been studied in adults with and without diabetes against the Structured Clinical Interview for DSM-IV, showing excellent sensitivity (94-100%) and specificity (78%) (6; 7). Given its brevity and focus on positive affect, the WHO-5 may be a suitable instrument to screen for low emotional well-being and depressive affect in adolescents with diabetes. Moreover, as the WHO-5 is a generic measure, it allows for comparison with healthy peers and is available in a multitude of languages. However, only one study so far used the WHO-5 in young men, but no validation data were reported (8). We therefore set out this study to investigate the reliability and validity of the WHO-5 in adolescents with type 1 diabetes.

**RESEARCH DESIGN AND METHODS**

Participants between the age of 13 and 17 were recruited from four pediatric outpatient clinics in the Netherlands as part of a larger psychosocial research project. Insufficient language skills and diabetes duration shorter than 6 months were exclusion criteria. Of the total 171 eligible subjects, 91 adolescents with type 1 diabetes consented to participate. The study was approved by the Medical Ethical committees of all hospitals and written informed consent was obtained from both patients and parents. The adolescents who chose not to participate did not differ in age, gender or HbA1c from participating adolescents. Non-participants were, however, more likely to be from an ethnic minority.

**Measures**

The WHO-5 captures emotional well-being and was developed from the WHO-10 Well-Being Index (9; 10). It was conceptualized as a uni-dimensional measure that contains five positively worded items: ‘I have felt cheerful and in good spirits’; ‘I have felt calm and relaxed’; ‘I have felt active and vigorous’; ‘I woke up feeling fresh and rested’; ‘My daily life has been filled with things that interest me’.

The degree to which the aforementioned positive feelings were present in the last two weeks is scored on a 6-point Likert scale ranging from 0 (not present) to 5 (constantly present). The raw scores are transformed to a score from 0 (worst thinkable well-being) to 100 (best thinkable well-being). A score ≤50 suggests poor emotional well-being and is a sign for further testing. A score below 28 is indicative for depression (6). In adults, the WHO-5 proved to be a highly sensitive screener for depressive affect (6; 7).

In addition to the WHO-5, the Centre for Epidemiological Studies Depression scale (CES-D), two subscales of the 87-item child report version of the Child Health Questionnaire (CHQ-CF87) evaluating Mental Health and Self-esteem and the Diabetes Family Conflict Scale (DFCS) were completed.

The CES-D consists of 20 items (4 positive and 16 negative items) and is scored from 0 (never) to 3 (daily) on the basis of frequency of depressive symptoms reported in the past week (11). Total CES-D summation scores range from 0 (no depressive symptoms) to 60 (most frequent/severe depressive symptoms). In adults, a cut-off score of 16 is used to define likely depression. However, this criterion has yielded mixed results in adolescents (12-15), and a cut-off of 24 was suggested to improve the correlation with DSM defined depression (16). Similar to the US National Longitudinal Study of Adolescent Health and the SEARCH for diabetes in youth study, we adapted this cut-off score and stratified depressive affect as ‘minimal’ (0–15),
‘mild’ (16–23), and ‘moderate/severe’ (≥24) (3; 17).

The Mental Health (16 items) and Self-esteem (14 items) subscales of the CHQ-CF87 are scored from 1 to 5 and transformed to a score between 0 and 100, with higher scores representing better well-being. The ratings of all scales are based on children’s functioning over the previous 4 weeks (18).

The adapted version by Laffel et al. of the Diabetes-specific Family Conflict Scale (DFCS) assesses the current degree of family conflict on 19 management tasks rated on a 3-point Likert scale. The DFCS does not specify a time frame (19). Higher scores indicate more conflicts.

Statistical analyses

As the WHO-5 was originally developed for adults, it is important to assess the readability of the measure. For this purpose we calculated the Flesch reading ease score. This score is based on the average number of syllables per word and the average sentence length. Higher scores represent better readability; eight grade students could easily understand passages with a score of 70 (20).

Confirmatory factor analysis (CFA) was conducted by structural equation modeling (SEM) to confirm the factor structure established in adult studies, using Mplus version 3.13. The \( \chi^2 \), root-mean-square error of approximation (RMSEA) and Comparative Fit Index (CFI) were calculated. Indicative for adequate fit are RMSEA values between 0.08 and 0.10 and CFI values above 0.90. An exploratory factor analysis (EFA) using principal component analysis was used to study the appropriateness of this factor structure in our adolescent population. Only components with Eigenvalues > 1.0 should be retained, together explaining over 50 % of the total variance and showing factor loadings > 0.40 (21). Internal consistency by Cronbach’s \( \alpha \), item-total and inter-item correlation were calculated to assess the reliability of the scale. For internal consistency, an \( \alpha \) of 0.70-0.80 is desirable and the item-total correlation should be above 0.20. A high inter-item correlation (> 0.80) is an indication of redundancy and is therefore not desirable. In contrast, if all correlations are near zero, there is no meaningful construct (22).

Concurrent validity was examined by calculating Pearson and Spearman correlation coefficients between the questionnaires. In case of similar constructs, correlations above 0.50 are an indication for good concurrent validity. These correlations could be expected for the CES-D and Mental Health subscale of the CHQ-CF87. Poor well-being is expected to be associated with more family conflicts and low self-esteem, although not to the extent that it measures the same construct. We therefore expect moderate correlations between 0.30 and 0.50 (23). The sensitivity (proportion of truly diseased individuals identified) and specificity (proportion of truly non-diseased individuals identified) were investigated using receiver operating characteristic (ROC) curves analyses. The cut-off scores used in adult populations (28 and 50) were related to the cut-off points of the CES-D (respectively 24 and 16).

In addition to the reliability and validity, differences in gender, ethnicity (Caucasian or not), one- or two parent family and treatment regimen were tested using analysis of variance (ANOVA). Correlations between the WHO-5, age, HbA1c, BMI and diabetes duration were explored using Pearson correlation coefficients. SPSS version 14.0 was used to execute analyses, \( p<0.05 \) was considered a significant difference.

RESULTS

Forty-seven boys and 44 girls with a mean age of 14.9 ± 1.1 years (range 13 – 16.5) were included. Mean diabetes duration was 6.4 ± 4.2 years and mean HbA1c level was 8.8 ± 1.7 % (range 6.2 – 15.0). Nineteen percent of the adolescents lived in a single-parent family. Eleven percent of the adolescents were from an ethnic minority. Mean score on the WHO-5 was 63.38 ± 18.9 (range 4.0 – 96.0).

The Flesch reading ease score of 90.0 indicated good readability. The CFA confirmed
the one-factor structure of the WHO-5 with no significant proportion of unexplained variance ($\chi^2 = 6.75 (5), p = 0.24$), an RMSEA of 0.062 and a CFI of 0.99. The Cronbach’s $\alpha$ was 0.82 and item-total correlations ranged from 0.50 to 0.72. Inter-item correlation ranged from 0.33 to 0.74. The subsequent principal component analysis also suggested a uni-dimensional structure of the WHO-5 because the first Eigenvalue was 3.1 while the other Eigenvalues were < 1.0. The explained variance was 62.5 % and the factor loading for the items ranged from 0.67 to 0.86.

As expected, higher WHO-5 scores were strongly associated with lower total CES-D and higher Mental Health subscale scores ($r = -0.67$ and $r = 0.60$, $p < 0.001$). More diabetes specific family conflicts and lower Self-esteem were moderately associated with lower WHO-5 scores ($r = -0.34$ and 0.43, $p<0.001$). The positive subscale of the CES-D and WHO-5 correlated moderately ($r = 0.45$, $p<0.001$). WHO-5 scores were not significantly associated with the clinical variables HbA1c ($r = -0.16$, $p=0.14$), diabetes duration, treatment regimen or BMI (data not shown). WHO-5 scores did not differ for gender, age, ethnicity, or family structure.

Analyses of the ROC curves confirmed the cut-off of $\leq 50$ to be optimal for detecting mild to severe depressive affect (CES-D score $\geq 16$) (Figure 1). With a significant area under the curve (AUC) of 0.95 (CI 0.91-0.99), the sensitivity was 89 % with a specificity of 87 %. This cut-off score identified all cases with CES-D $\geq 24$, indicative for severe depressive affect. For identification of those adolescents with an indication of moderate to severe depressive affect, a cut-off score of 28 appeared appropriate (Table 1).

**CONCLUSIONS**
This is the first study to examine the psychometric properties of the WHO-5 in adolescents with type 1 diabetes. Our findings suggest good reliability and validity of the WHO-5, particularly given its brevity. All items were completed and readability scores were sufficient. It would therefore seem safe to conclude that the WHO-5 is a suitable instrument to use in adolescents.

The uni-dimensional structure of the questionnaire was confirmed in EFA and CFA in our adolescent population. Further research is needed to examine the stability (test-retest) and responsiveness of the WHO-5 in adolescents. Concurrent validity was confirmed by the moderate to strong correlations with other relevant questionnaires. It would appear that the difference in time frames between the WHO-5 (past 2 weeks), the CES-D (past week) and CHQ-CF87 (past 4 weeks) has not decreased the strength of the associations.

The WHO-5 measures (the absence of) positive affect rather than the presence of negative emotions. The strong correlation between the WHO-5 and the negatively worded items of the CES-D seems to favor the conceptualization of well-being as a continuum, with well-being and depressive affect as extremes rather than orthogonal dimensions (25). The WHO-5 was only moderately associated with the positively worded items of the CES-D. This could be due to the differences in Likert scales and item content. The WHO-5 is more focused on vigor and activity, whereas the positive subscale of the CES-D taps into feelings of self-worth and pleasure.

In our sample, those adolescents reporting low positive affect reported more negative affect on the CES-D and vice versa, confirming high sensitivity for detection of depressive affect by the WHO-5 in our sample. While the presence of positive affect seems not to be associated with better glycemic control, more negative affect did show a moderately strong association with higher HbA1c levels in concert with research findings in adults (26).

We found the specificity of the WHO-5 to be relatively high, suggesting that the cut-off score of 50 as an indication for further testing for
depression is appropriate for both adults and adolescents. It should be noted that only a few adolescents in our sample reported depressive symptoms, which could have resulted in relatively high sensitivity. Further research in a sample of adolescents with more depressive symptoms is therefore warranted, comparing WHO-5 scores to a diagnostic interview as the gold standard.

Although previous studies reported more depressive affect in girls as compared to boys, we did not find such a gender effect (2; 3). The difference in prevalence rates between boys and girls starts to emerge around the age of 15, where prevalence rates of depressive affect increases in girls, while they remain stable in boys (27). The small sample size and relatively low number of depressed patients precluded examining the group of adolescents above 15 years separately.

The WHO-5 has the advantage to be a generic measure of emotional well-being, allowing for comparison of well-being with healthy peers. Moreover, the scale can also be used to evaluate the parents’ well-being and is freely available in a multitude of languages (www.who-5.org). However, it does not capture diabetes-specific distress for which other reliable instruments are available (e.g. PedsQL-diabetes module, DQOL-Youth (28)). In a stepped approach, the WHO-5 could be used as a first screener alone or in combination with a diabetes-specific instrument, followed by a more extensive psychological assessment e.g. using the SDQ (29).

In conclusion, the WHO-5 appears to be a suitable instrument to help detect and address emotional problems in adolescents with diabetes as part of clinical routine.

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References


**Table 1** Sensitivity and specificity of the WHO-5 at the two cut-off scores for identifying mild and moderate to severe depression

<table>
<thead>
<tr>
<th>WHO-5</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Sensitivity</th>
<th>Specificity</th>
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<tr>
<td>≤ 28</td>
<td>44 %</td>
<td>96 %</td>
<td>67 %</td>
<td>95 %</td>
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<tr>
<td>&lt; 50</td>
<td>89 %</td>
<td>87 %</td>
<td>100 %</td>
<td>82 %</td>
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**CES-D**

<table>
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<tr>
<th>≥16 (mild to severe depression)</th>
<th>≥24 (moderate to severe depression)</th>
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Figure 1

A: ROC Curve

Diagonal segments are produced by ties.

B: ROC Curve

Diagonal segments are produced by ties.