Cross Validation of the Prodromal Questionnaire 16-Item Version in an Adolescent Help-Seeking Population

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The Prodromal Questionnaire 16-item version (PQ-16) is used as a screener in the early detection of psychosis. We wished to cross-validate it in a help-seeking population of adolescents aged 12–17 who had been referred for assessment and treatment to an outpatient Center for Child and Adolescence Psychiatry (CCAP). To examine the psychometric properties of the PQ-16 for adolescents, we used reliability analysis and receiver-operating-characteristic (ROC) curves. The internal consistency of the 16-item version was good, with Chronbach’s $\alpha = 0.84$. A cutoff of 7 or more items marked as true, showed acceptable sensitivity (.77) and specificity (.55). Half (51.3%) of the above cutoff sample were classified by the Comprehensive Assessment of At-Risk Mental States (CAARMS) assessment as having Ultra-High Risk (UHR) status or as having reached the psychosis threshold. Differentiation between boys and girls showed that the use of distress scores improved sensitivity and specificity values for girls but worsened them for boys. When a cutoff score of 7 or more items marked as true is used, the PQ-16 is a feasible instrument with acceptable screening properties for UHR and psychosis in boys and girls aged 12–17 attending a CCAP.

Key words: early detection/at-risk mental state/attenuated psychotic symptoms/psychosis/schizophrenia/adolescence

Introduction

Early detection and intervention have proved to be effective, cost-saving methods of preventing a first episode of psychosis in adults aged 18 years and older.1–4 Psychotic disorders generally emerge at young adult age, usually preceded by a prodromal phase.5,6 Age at onset seems to differ between boys and girls, especially in schizophrenia. Men usually develop this disorder at a mean age of 18–25, and women at 25–35, although women also have a peak in early-onset after their first menarche.7 Adolescence, therefore, seems the right phase to intervene. Screening methods can be used to find subjects for whom intervention may be appropriate.

Several self-report forms are used as a first-step psychosis-risk screener8 followed by an interview using the Comprehensive Assessment of At-Risk Mental States (CAARMS9) or the Structured Interview for Prodromal Syndromes (SIPS10). Screeners with a narrow focus on attenuated positive symptoms validated against these interviews—such as different versions of the Prodromal Questionnaire (PQ11), the Prime Screen (PS10) and the Early Psychosis Screener for Internet (EPSI12)—appear to align more reliability with CAARMS and SIPS diagnoses. Although the PQ-16-item version (PQ-16) is a common screening instrument for psychosis, it was validated largely in an adult population.11

The PQ-16 was derived from the PQ-92, which had been developed as a first-step screening tool for the early detection of psychotic disorders or Ultra-High Risk (UHR) state.13 Usually, if a person scores above a cutoff of 6 or more items marked as true (hereafter “agreed items”), clinical diagnosis is established using the CAARMS.9 In adults, a cutoff of ≥6 agreed items on the PQ-16 predicted a CAARMS diagnosis of UHR or psychotic disorder with high sensitivity (87%) and specificity (87%).13

Psychotic symptoms occur more commonly in adolescence than during adulthood, especially in girls.14–16 They are usually transient in nature.17–19 The PQ-16 covers mainly psychotic or psychotic-like experiences (14 out of a total 16 items13). Although we previously reported that 34.7% of the 12- to 17-year-olds seen at a Center
for Child and Adolescence Psychiatry (CCAP) reached the cutoff of ≥6 agreed items, the association between UHR status or psychotic disorder and cutoff scores on the PQ-16 has not yet been assessed. We, therefore, wished to cross-validate the PQ-16 as a first-step screen in a large adolescent help-seeking population of 12- to 17-year-olds who had been referred for assessment and treatment to a CCAP in the Netherlands.

**Methods**

**Setting and Procedures**

All participants were recruited at Youz, an outpatient Center for Child and Adolescence Psychiatry (CCAP) in Rotterdam Rijnmond, an urban area in the Netherlands. These help-seeking adolescents, who had been referred for assessment and treatment, were included if they were aged between 12 and 17 at intake, had a psychiatric DSM-IV or DSM-5 diagnosis, and had undergone intake between February 20, 2014 and January 16, 2018. A DSM diagnosis was determined after a face-to-face intake procedure in which the clinician evaluated the adolescent for the psychiatric signs he, she or the parents had reported. Adolescents without a DSM diagnosis are not part of the CCAP care program and are referred to as non-psychiatric youth services. Due to the ability to display false negatives, only adolescents whose psychotic disorder prevented them from participating were excluded from our sample.

As part of the routine registration procedures in this cross-sectional study, all adolescents filled out the PQ-16. They and one or both parents also filled out the Achenbach System of Empirically Based Assessment (ASEBA) questionnaires. The PQ-16 and ASEBA questionnaires are part of the Routine Outcome Monitoring (ROM) that is obligatory in the Netherlands. All adolescents with the current cutoff score of 6 and higher on the PQ-16 were invited for a CAARMS interview. To determine sensitivity and specificity (see statistics), we also invited a subsample of 56 adolescents with a score of 5 and lower. If adolescents were aged 12–15 years, parents were also invited to be present for the first 30 minutes. If, in all cases, an adolescent’s parents had not been present, they were approached by phone to answer informant questions on the CAARMS.

To prevent stigma at the screening stage, we used the term “unusual experiences.” Data were used for research purposes on a strictly anonymous basis, as approved by the Dutch Union of Medical-Ethics Trial Committees for Mental Health Organizations (Number NL.44180.058.13). Participation was voluntary; refusing had no consequences.

**Measures**

**PQ-16.** The PQ-16 is derived from the PQ 92 (PQ-92) and is used for the early detection of psychosis. The 16 items derived from the PQ-92 were selected empirically on the basis of predictive power, not of content. These 16 items are dichotomous ratings (true or false). In addition, distress is measured on a 4-point scale for each item marked as true ranging from 0 (no distress) to 3 (severe distress). Research to date reports 3 ways of determining the PQ-16 total score. Method A is the original method, which consists of adding up the number of items marked as true (range 0–16). Method B adds up only those items marked as true that also have a distress level of 1–3 (range 0–16). Method C adds up all stress scores of items marked as true (hereafter “agreed items”; range 0–48).

**CAARMS.** The CAARMS is a semi-structured clinical interview that is often used to identify patients at risk for a first psychotic episode or to identify patients already experiencing a psychotic episode. The CAARMS is administered after a participant scores above a cutoff score on a self-report screening tool such as the PQ-16. The CAARMS distinguishes 3 UHR groups and a psychotic threshold group:

1. A genetic group, in which psychotypical disorder has been diagnosed in the participant or in a first-degree family member with a psychotic disorder.
2. A group with “attenuated” psychotic symptoms, ie, with positive psychotic symptoms that have developed or worsened in the last 12 months.
3. A group with short limited transient psychotic symptoms, in which, within the last 12 months, the participant has either experienced psychotic symptoms that lasted no longer than a week, or symptoms that resolved without treatment.

To reach consensus, trained CAARMS interviewers met frequently to discuss and judge cases. All interviewers were blind to the PQ-16 score.

**Statistical Analysis**

All analyses were performed using SPSS version 25.0. The reliability of the PQ-16 was determined by Chronbach’s α. The first priority in this study was to determine the cutoff. To compare the differences between all the total scores of the PQ-16 and the CAARMS outcome of UHR, or the psychosis threshold, we performed an ANOVA with post hoc Bonferroni. None of these scores differed significantly (1% level) between the mean scores of the UHR and the psychosis threshold group. This confirmed that the PQ-16 does not measure the intensity differences between UHR and psychosis. For that reason, the UHR and the psychosis threshold group were combined in one group: CAARMS outcome.
To determine a cutoff score on the PQ-16 we performed a ROC analysis, including the area under the curve (AUC) with the PQ-16 total score as test variable and the CAARMS outcome as state variable, in which UHR and psychotic threshold were combined. AUC scores above .70 are considered clinically useful. We also determined sensitivity, specificity, positive predictive values (PPV), and negative predictive values (NPV). Since a false positive was followed not by an invasive procedure, but by a second-step diagnostic CAARMS interview to eliminate false positives on the first step with PQ-16, we aimed to include as many adolescents as possible with a high sensitivity and with a specificity not lower than .5.

**Results**

**Sample Characteristics**

The mean age of the sample (n = 325) was 14.78 years (SD = 1.58, range: 12–17). Mean Global Assessment of Functioning (GAF) was 52.37 (SD 5.22), indicating that functioning in members of the sample was seriously limited. Figure 1 shows a flowchart of participants and table 1 lists sample characteristics. The eligible sample did not differ in age or gender from the initial referral group. However mean GAF scores were significantly lower (m = 52.5, SD 5.75 vs m = 56.9, SD 7.22 (df 1175) P = .00) and the different mean total scores on the PQ-16 were significantly higher; those calculated with method A being m = 5.53, SD 3.89, range 0–16 vs m = 4.24, SD 3.37, range 0–13 (df 906), P = .01; those calculated with method B being m = 4.39, SD 3.66, range 0–16 vs m = 3.50, SD 3.20, range 0–13 (df 904), P = .03; and those calculated with method C being m = 7.33, SD = 7.28, range 0–40 vs m = 5.28, SD = 5.34, range 0–25 (df 904), P = .01 (Figure 2).

**Internal Consistency of the PQ-16**

The internal consistency of the PQ-16 was good (Chronbach’s α = 0.84 for the total group; 0.82 for boys and 0.84 for girls). Consistency was not increased by the deletion of items.

**Cutoff Scores in Adolescence**

**Method A (Total PQ-16 Scores Only Including Agreed Items). Total Group** A cutoff of 7 or more items showed an AUC of .73, and the best specificity and sensitivity values (table 2). Of the 51.3% participants classified as having a CAARMS diagnosis (n = 116), 41.6% (n = 94) were identified as UHR and 9.7% (n = 22) reached the psychosis threshold. This represents a percentage of 8.3% UHR and a 1.9% psychosis threshold in the total group (n = 1135).

**Gender Groups** The AUC of .69 for boys was lower than the AUC of .74 for girls. For boys, a cutoff of 7 or more items remained the best cutoff. For girls, however, a cutoff score of 8 or more items showed a balance between sensitivity and specificity scores. When the cutoff score of 7 or more items was applied to girls, more true-positive cases and fewer true-negative cases were determined (table 2). The sex distribution was skewed.
and the number of boys was too small to reach reliable conclusions.

Method B (Total PQ-16 Scores Including Only Agreed Items That Also Have a Distress Level of 1–3). Total Group. After inclusion only of items with distress in the PQ-16 total score, 324 participants remained in the analyses due to missing values. The AUC was .72. The best values were produced by a cutoff score of 6 items (table 3).

Gender Groups. The best cutoff for boys was 5 (table 3). However, the AUC value of .65 fell below a clinically relevant level, with a high negative predictive value and low positive predictive value. For girls, the best cutoff was 6 or more agreed items with a distress level of 1–3. The AUC was .74 (table 3).

Method C (Total PQ-16 Scores Including the Total of Distress Scores). Total Group. The AUC was .73. A cutoff score of 8 produced the best screening values.

Gender Groups. The AUC for boys was .64 and for girls .76. For boys and girls alike, the cutoff remained a total stress score of 8. Once again, however, screening values for boys lay below clinically relevant level (table 3).
In our determination of a cutoff score on the PQ-16 for adolescents attending a CCAP, we found that a cutoff score of 7 or more agreed items, was produced by using the original method to add up the items marked as true. This cutoff score showed acceptable screening values and classified half of the participants reaching this cutoff score as having UHR or as having reached the psychosis threshold according to the CAARMS. Since a false positive was followed not by an invasive procedure, but by an interview eliminating false positives on the PQ-16, we aimed to include as many adolescents as possible with high sensitivity and specificity not lower than .5. 

With this cutoff score, there were more true positives than false positives. The number of false negatives were also relatively small, which is preferable, as one does not want to miss cases during screening. If an institution has the financial means to interview over 50% of new referrals, it may also consider choosing a lower cutoff score. However, this would raise the number of false positives, possibly increasing the unnecessary burden on adolescents, parents, and clinicians.

Table 2. Screening Properties of the PQ-16, Comprehensive Assessment of At-Risk Mental States (CAARMS) Diagnosis of UHR or Psychotic Threshold vs No CAARMS Diagnosis, Using Method A

| PQ-16 Cutoff | Sensitivity | Specificity | PPV | NPV | True Positives | True Negatives | False Positives | False Negatives |
|--------------|-------------|-------------|-----|-----|----------------|----------------|----------------|----------------|
| Total group, n = 325 |
| 4 | 0.97 | 0.18 | 44.9 | 92.3 | 134 | 24 | 165 | 2 |
| 5 | 0.93 | 0.25 | 46.2 | 89.7 | 132 | 35 | 154 | 4 |
| 6 | 0.85 | 0.42 | 47.1 | 82.5 | 126 | 47 | 142 | 10 |
| 7 | 0.77 | 0.55 | 51.3 | 79.8 | 116 | 79 | 110 | 20 |
| 8 | 0.65 | 0.69 | 55.3 | 77.0 | 105 | 104 | 85 | 31 |
| 9 | 0.51 | 0.81 | 60.3 | 73.6 | 89 | 131 | 58 | 47 |
| Girls, n = 217 |
| 4 | 0.98 | 0.16 | 49.3 | 91.7 | 101 | 11 | 104 | 1 |
| 5 | 0.92 | 0.23 | 50.7 | 90.0 | 100 | 18 | 97 | 2 |
| 6 | 0.87 | 0.38 | 51.3 | 76.5 | 94 | 26 | 89 | 8 |
| 7 | 0.78 | 0.55 | 55.6 | 77.2 | 89 | 44 | 71 | 13 |
| 8 | 0.70 | 0.70 | 60.3 | 73.3 | 79 | 63 | 52 | 23 |
| 9 | 0.55 | 0.83 | 67.0 | 72.1 | 71 | 80 | 35 | 31 |
| Boys, n = 108 |
| 4 | 0.94 | 0.23 | 35.1 | 92.9 | 33 | 13 | 61 | 1 |
| 5 | 0.94 | 0.28 | 35.9 | 89.5 | 32 | 17 | 57 | 2 |
| 6 | 0.79 | 0.47 | 37.7 | 91.3 | 32 | 21 | 53 | 2 |
| 7 | 0.77 | 0.55 | 40.9 | 83.3 | 27 | 35 | 39 | 7 |
| 8 | 0.53 | 0.69 | 44.1 | 83.7 | 26 | 41 | 33 | 8 |
| 9 | 0.38 | 0.78 | 43.9 | 76.1 | 18 | 51 | 23 | 16 |

Note: Bold values represent the selected cutoff. NPV, negative predictive values; PPV, positive predictive values; PQ-16, Prodromal Questionnaire 16-item version; UHR, ultra-high risk.

Discussion

In our determination of a cutoff score on the PQ-16 for adolescents attending a CCAP, we found that a cutoff score of 7 or more agreed items, was produced by using the original method to add up the items marked as true. This cutoff score showed acceptable screening values and classified half of the participants reaching this cutoff score as having UHR or as having reached the psychosis threshold according to the CAARMS. Since a false positive was followed not by an invasive procedure, but by an interview eliminating false positives on the PQ-16, we aimed to include as many adolescents as possible with high sensitivity and specificity not lower than .5. 

With this cutoff score, there were more true positives than false positives. The number of false negatives were also relatively small, which is preferable, as one does not want to miss cases during screening. If an institution has the financial means to interview over 50% of new referrals, it may also consider choosing a lower cutoff score. However, this would raise the number of false positives, possibly increasing the unnecessary burden on adolescents, parents, and clinicians.

Although the psychometric values for girls were slightly better than those for boys, differentiating between boys and girls did not influence the determination of a cutoff score. When only items with distress (method B) were included in the PQ-16 total score, the use of distress scores did not generate cutoff scores with better sensitivity and specificity values. However, while calculating total distress scores on the PQ-16 by including all distress scores (method C) did slightly improve values for girls, it worsened them for boys.

The fact that the cutoff score of 7 on the PQ-16 was one point higher than the score in the adult population may be explained by the higher prevalence of psychotic-like experiences in adolescence. The sensitivity and specific scores in our study were comparable with those found by O’Donoghue et al. in patients aged 15 to 24 who had been referred to 4 streams of specialist care: early psychosis, UHR, depression, or personality disorder. A cutoff score of 7 is also in line with research by McDonald et al., who investigated an online version of the PQ-16 in a mixed sample of general and help-seeking 16- to 35-year-olds. The sensitivity and specificity scores in our sample were also comparable with the scores found using other screeners such as the PS, which had a sensitivity of .80 and a specificity of .48 in a sample aged 12–22. These screeners were developed to detect people with UHR and psychosis together. The EPSI was developed to predict conversion in a 14–35 aged sample and thus measures a different outcome.

In contrast with our own findings, researchers in the ReARMS project (Reggio Emilia At-Risk Mental States) found best values for a cutoff score of ≥6 on the PQ-16, in a sample of 13- to 17-year-olds who had been referred to the neuropsychiatry services on the basis of pre-selection using the Screening Schedule for Psychosis. Preselecting...
for true psychotic symptoms probably ensures that adolescents with more transient and less severe psychotic symptoms will be excluded from the sample. This might justify a lower cutoff score than we found when we included all adolescents with psychiatric disorders.

A possible reason that determination of the cutoff score on the PQ-16 produced better sensitivity and specificity values for girls than for boys is that girls experience more positive symptoms than boys. It is also the case the prevalence of sexual abuse is higher in girls than in boys and is associated with a higher prevalence of psychotic experiences. Although the evidence is contradictory, some researchers have reported that boys had more negative symptoms than girls. Nonetheless, the PQ-16 contains only 2 negative-symptom items.

In their study on young adult outpatients at an early-detection psychosis service, Schultze-Lutter et al reported that improvements in sensitivity and individual risk-estimation rates were improved by combining UHR criteria and the basic symptom (BS) criterion “cognitive disturbances”. Both UHR and BS are included in the clinical staging model of CHR-p as defined by Fusar-Poli. Overall screening properties for boys might be improved by combining screening methods for detecting these different CHR-p groups—potentially a subject that would justify future research.

The use of methods of calculating PQ-total scores by including stress scores did not improve overall sensitivity and specificity values. Not only may stress be more common in adolescents attending a CCAP, adolescents with psychotic symptoms who are used to these symptoms are likely to experience less distress, and thus more likely to report them without reporting distress. Research on the importance of including the PQ-16’s self-reported distress scores in the analyses has so far been inconclusive. Kline et al reported that focusing only on psychotic-like experiences associated with distress improved prediction of clinical high-risk status. Participants who met UHR criteria were found to report more distress per psychotic-like experience than those with psychiatric disorders who did not. However, Power et al found no association between the higher levels of distress associated with attenuated psychotic symptoms and those associated with the transition to psychosis. Until further research shows otherwise, determining a total score on the basis of the original method of counting agreed items on the PQ-16, therefore, seems to be the most accurate.

Table 3. Comparison of Cutoff Scores With the Best Values in Scoring Methods B and C by Including Distress, per Gender and in the Total Group

| PQ-16 Cutoff | Sensitivity | Specificity | PPV  | NPV  | True Positives | True Negatives | False Positives | False Negatives |
|--------------|-------------|-------------|------|------|----------------|----------------|----------------|----------------|
| Method B     |             |             |      |      |                |                |                |                |
| Total Group  |             |             |      |      |                |                |                |                |
| n = 324      |             |             |      |      |                |                |                |                |
| 5            | .79         | .47         | 50.2 | 82.4 | 120            | 70             | 119            | 15             |
| 6            | .70         | .62         | 51.4 | 75.9 | 107            | 88             | 101            | 28             |
| 7            | .55         | .73         | 56.6 | 74.1 | 94             | 117            | 72             | 41             |
| Boys, n = 108|             |             |      |      |                |                |                |                |
| 4            | .79         | .42         | 37.5 | 85.7 | 30             | 24             | 50             | 4              |
| 5            | .68         | .54         | 38.6 | 81.6 | 27             | 31             | 43             | 7              |
| 6            | .53         | .66         | 40.4 | 78.4 | 23             | 40             | 34             | 11             |
| Girls, n = 216|            |             |      |      |                |                |                |                |
| 5            | .83         | .42         | 55.0 | 83.0 | 93             | 39             | 76             | 8              |
| 6            | .75         | .59         | 55.6 | 73.8 | 84             | 48             | 67             | 17             |
| 7            | .58         | .73         | 61.8 | 73.1 | 76             | 68             | 47             | 25             |
| Method C     |             |             |      |      |                |                |                |                |
| Total group, |             |             |      |      |                |                |                |                |
| n = 324      |             |             |      |      |                |                |                |                |
| 7            | .84         | .45         | 50.4 | 81.8 | 119            | 72             | 117            | 16             |
| 8            | .80         | .54         | 52.3 | 80.2 | 114            | 85             | 104            | 21             |
| 9            | .73         | .59         | 55.7 | 79.2 | 108            | 103            | 86             | 27             |
| Boys, n = 108|             |             |      |      |                |                |                |                |
| 7            | .68         | .46         | 36.4 | 76.2 | 24             | 32             | 42             | 10             |
| 8            | .65         | .57         | 36.5 | 75.6 | 23             | 34             | 40             | 11             |
| 9            | .59         | .63         | 40.7 | 77.8 | 22             | 42             | 32             | 12             |
| Girls, n = 216|            |             |      |      |                |                |                |                |
| 7            | .90         | .44         | 55.9 | 87.0 | 95             | 40             | 75             | 6              |
| 8            | .85         | .53         | 58.7 | 83.6 | 91             | 51             | 64             | 10             |
| 9            | .77         | .56         | 61.4 | 80.3 | 86             | 61             | 54             | 15             |

Note: For more cutoffs and screening values see supplementary material. NPV, negative predictive values; PPV, positive predictive values; PQ-16, Prodromal Questionnaire 16-item version.
Strengths and Limitations

The strength of this study is that, to our knowledge, we were the first to assess cutoff scores using the PQ-16 in relation to the CAARMS in a large sample of adolescents aged 12–17 who had been referred to a CCAP without pre-selection or a focus on specific psychiatric disorders.

A limitation is the small sample of those scoring <6 on the PQ-16, a majority of whom not only scored 4 or 5 on the PQ-16 but also seemed to be more willing to participate. Together, this small sample and this majority may have influenced our determination of the cutoff score. However, if all adolescents scoring lower than 6 on the PQ-16 are included, positive and negative predictive values might produce better values—possibly producing a higher number of patients who score lower on the PQ-16 but who do not meet the criteria for a CAARMS diagnosis.

Another limitation is that we did not assess the reading level. Some of the items of the PQ-16 may be difficult for adolescents to interpret; if so, this may have produced more false positives vis-à-vis the CAARMS diagnosis. Also, some questions of the CAARMS are formulated in difficult language, causing interviewers to simplify questions for young adolescents. Although it is unclear which influence this may have had, all interviewers were trained child-and-adolescent professionals, who frequently met to discuss and judge cases for consensus.

A third potential limitation is that it is not known whether parents’ perceptions affect completion of the PQ-16.

A fourth limitation is our inclusion of adolescents on the basis of a DSM diagnosis that was not supported by a validated structured clinical interview. Instead, a clinician had based it (1) on his or her evaluation of the signs and symptoms indicated by adolescents and their parents, and (2) on consulting the ASEBA questionnaires that these adolescents and their parents had completed.

A further limitation is that the number of participants classified as UHR, who eventually convert to psychosis is unknown in the present study. Finally, as our study focused on adolescents referred to a CCAP, our results cannot be generalized to the general population.

Conclusion

Our results show that if a cutoff of 7 or more items marked as true is applied, the PQ-16 is a feasible instrument with acceptable screening properties for screening for UHR and psychosis in boys and girls aged 12–17 attending a CCAP.

Supplementary Material

Supplementary data are available at Schizophrenia Bulletin Open online.

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