Analysis of the Sport Mental Health Assessment Tool 1 (SMHAT-1) in Team USA athletes

Travis Anderson, William M Adams, Jessica D Bartley, Angel L Brutus, Amber T Donaldson, Jonathan T Finno

ABSTRACT
Objective The Sport Mental Health Assessment Tool 1 (SMHAT-1) was introduced as a critical component to the athlete health evaluation. However, the effectiveness of the initial triage step questionnaire (Athlete Psychological Strain Questionnaire (APSQ)) has yet to be analysed within a National Olympic and Paralympic Committee delegation. This study evaluated the ability of the APSQ to identify athletes at risk for mental health concerns.

Methods Athletes completed the APSQ and all subsequent screening questionnaires of the SMHAT-1 as part of their Tokyo and Beijing Olympic and Paralympic Games health history screening. Each questionnaire was scored according to published guidelines, and the false-negative rate (FNR) for the APSQ identifying athletes that were positively screened on the subsequent questionnaires was computed.

Results 1066 athletes from 51 different Olympic and Paralympic and Summer and Winter sports completed the SMHAT-1. The FNRS for all athletes who were positively screened on a subsequent questionnaire with an APSQ score of <17 ranged from 4.8% to 66.7%. The global FNR for being positively screened on any questionnaire was 67.5%. Female, Paralympic and Winter athletes scored higher on one or more questionnaires compared with male, Olympic and Summer athletes, respectively (p<0.05).

Conclusion Due to the high FNR of the APSQ detecting a potential mental health concern, we recommend athletes complete the APSQ and all subsequent questionnaires of the SMHAT-1 rather than using only the APSQ as an initial screening test.

INTRODUCTION
The Sport Mental Health Assessment Tool (SMHAT-1) was developed by the International Olympic Committee in 2021 to screen for mental health concerns in athletes. The SMHAT-1 consists of a multistep process; step 1 consists of a short questionnaire to triage the athletes; step 2 employs additional questionnaires to screen for specific mental health concerns; and step 3 consists of follow-up and formal evaluations by clinicians who then provide recommendations for additional services when appropriate. In order to first triage athletes, the 10-item Athlete Psychological Strain Questionnaire (APSQ)2 is used, and athletes scoring 17 or greater are assessed further by a series of validated questionnaires: the General Anxiety Disorder-7 (GAD-7), the Patient Health Questionnaire-9 (PHQ-9), the Alcohol Use Disorders Identification Test Consumption (AUDIT-C), and the Brief Eating Disorders in Athletes Questionnaire (BEDA-Q).

WHAT IS ALREADY KNOWN ON THIS TOPIC
- The Sport Mental Health Assessment Tool 1 (SMHAT-1) is used to screen athletes for potential mental health concerns and is constructed from validated questionnaires.

WHAT THIS STUDY ADDS
- This is the first study to test the effectiveness of the triage step of the SMHAT-1 and to report the false-negative rates for subsequent questionnaires after completion of athlete triage. The overall FNR of the Athlete Psychological Strain Questionnaire (APSQ) was 67.5%.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY
- This study suggests that the APSQ should not be used as a stand-alone initial triage step in the use of the SMHAT-1 in athletes; rather, the combination of steps 1 and 2 of the SMHAT-1 as the initial triage may be best served our athlete populations. If only the APSQ is used, we believe adding a screening question regarding self-harm and suicide should be strongly considered.
The choice to use a lower threshold is undoubtedly the score of ≥17 was aligned with the K10 ‘high’ category, despite aimed to evaluate the APSQ false-neg. It is critical to test and validate the APSQ in different athlete-conducting the SMHAT-specificity of the triage step) and to evaluate alternative options for Olympic and Paralympic, Summer and Winter sports in elite athletes.12 Despite these potential limitations, the APSQ is a short-form questionnaire with high internal consistency for male (Cronbach α=0.87) and female (Cronbach α=0.84) athletes,12 an acceptable discrimination for a number of psychological conditions and developed specifically for use in athletes, and was therefore chosen as the triage tool for the SMHAT-1. Since the SMHAT-1 is deployed internationally, across Summer and Winter sports, and with some athletes younger than 18 years of age, it is critical to test and validate the APSQ in different athlete populations.

Given these limitations and the associated concerns, this study aimed to evaluate the APSQ false-negative rate (FNR) for identifying which athletes would have a positive screen on subsequent SMHAT-1 questionnaires. Further, we aimed to validate the APSQ’s ability to correctly identify at-risk athletes across Olympic and Paralympic, Summer and Winter sports in elite male and female athletes (ie, examine the sensitivity and specificity of the triage step) and to evaluate alternative options for conducting the SMHAT-1.

METHODS
Study design and setting
A retrospective analysis of SMHAT-1 responses of Team USA athletes, including those competing in the Tokyo 2020 Olympic and Paralympic Games and the Beijing 2022 Olympic and Paralympic Games, was conducted. SMHAT-1 responses collected from 1 January 2021 to 19 July 2022 were included.

No specific efforts were made to recruit participants explicitly based on participant diversity. However, this study was conducted using Team USA athletes, a diverse population of elite athletes (sex: male=48.6% and female=51.4%; self-identified ethnic origin: Asian=2.44%, black=17.4%, white=62.8%, other=1.13%, two or more races=6.10%, declined to respond=9.94%; self-identified ethnicity: of Hispanic/Latino/Spanish origin=5.44%, not of Hispanic/Latino/Spanish origin=84.6%, declined to respond=9.94%; games: Olympic=90.9% and Paralympic=9.10%; season: Summer=66.5% and Winter=33.5%). The research team comprises a diverse, balanced group of expert clinicians and researchers (50% female). Because all athletes were required to complete the health history questionnaire before the games, efforts were made to ensure that they had access to the resources they required regardless of regional geographical differences, education or socioeconomic levels.

Data collection and measures
The SMHAT-1 was deployed via an online survey platform (Qualtrics, Provo, Utah, USA) and as part of a comprehensive elite athlete health survey recommended by the International Olympic Committee,1 athletes completed the APSQ and all subsequent questionnaires regardless of their score on the APSQ. This was an a priori decision made by the Sports Medicine team ahead of the Tokyo 2020 Games, given the novelty of the SMHAT-1’s use among elite athletes.

SMHAT-1 data were exported, and each questionnaire was scored using published guidelines.1 Readers are directed to Gouttebarge et al and the accompanying online supplemental material for additional details regarding the internal consistency, test–retest reliability, and specificity and sensitivity of the subsequent questionnaires. In this analysis, as shown in table 1, scores exceeding the thresholds were provided a clinical follow-up by a

Table 1

<table>
<thead>
<tr>
<th>Questionnaire</th>
<th>Theoretical score range</th>
<th>Threshold</th>
<th>All athletes</th>
<th>Sex</th>
<th>Male</th>
<th>Female</th>
<th>Games</th>
<th>Olympic</th>
<th>Paralympic</th>
<th>Season</th>
<th>Summer</th>
<th>Winter</th>
</tr>
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<tbody>
<tr>
<td>GAD-7</td>
<td>0–21</td>
<td>≥10</td>
<td>2.1±3.3 (0–18)</td>
<td>1.5±2.6 (0–18)</td>
<td>2.7±3.4 (0–17)*</td>
<td>2.0±2.9 (0–18)</td>
<td>3.3±3.9 (0–16)</td>
<td>2.2±3.2 (0–18)</td>
<td>1.8±2.8 (0–15)*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHQ-9</td>
<td>0–27</td>
<td>≥10</td>
<td>1.7±2.7 (0–18)</td>
<td>1.2±2.2 (0–18)</td>
<td>2.1±3.0 (0–18)*</td>
<td>1.6±2.6 (0–18)</td>
<td>2.5±3.3 (0–15)</td>
<td>1.9±2.9 (0–18)</td>
<td>1.2±2.0 (0–12)*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHQ-9 Q9</td>
<td>0–3</td>
<td>≥1</td>
<td>0.0±0.1 (0–1)</td>
<td>0.0±0.1 (0–1)</td>
<td>0.0±0.1 (0–1)</td>
<td>0.0±0.1 (0–1)</td>
<td>0.0±0.1 (0–1)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>ASSQ</td>
<td>0–17</td>
<td>≥8</td>
<td>4.9±2.8 (0–16)</td>
<td>4.8±2.8 (0–15)</td>
<td>5.1±2.8 (0–16)</td>
<td>4.9±2.8 (0–16)</td>
<td>5.4±2.5 (0–13)</td>
<td>5.1±2.9 (0–16)</td>
<td>4.6±2.6 (0 to 15)*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AUDIT-C</td>
<td>0–13</td>
<td>Male: ≥4</td>
<td>2.4±1.7 (0–11)</td>
<td>2.6±1.8 (0–11)</td>
<td>2.2±1.6 (0–8)*</td>
<td>2.4±1.7 (0–11)</td>
<td>2.7±1.7 (0–9)</td>
<td>2.2±1.7 (0–11)</td>
<td>2.8±1.7 (0–9)*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAGE-AID</td>
<td>0–4</td>
<td>≥2</td>
<td>0.0±0.3 (0–4)</td>
<td>0.0±0.4 (0–4)</td>
<td>0.04±0.3 (0–4)</td>
<td>0.05±0.4 (0–4)</td>
<td>0.04±0.2 (0–1)</td>
<td>0.05±0.3 (0–4)</td>
<td>0.0±0.4 (0–4)</td>
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</tr>
<tr>
<td>BEDA-Q</td>
<td>0–34</td>
<td>Female: ≥3</td>
<td>9.8±6.3 (0–31)</td>
<td>8.4±5.7 (0–24)</td>
<td>11.0±6.5 (0–31)*</td>
<td>9.7±6.3 (0–31)</td>
<td>10.5±6.3 (0–29)</td>
<td>10.4±6.3 (0–31)</td>
<td>8.6±6.0 (0–28)*</td>
<td></td>
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</tr>
</tbody>
</table>

*Significantly different from male athletes, Olympic athletes and summer athletes for sex, games and season, respectively (p<0.05).

APSQ, Athlete Psychological Strain Questionnaire; ASSQ, Athlete Sleep Screening Questionnaire; AUDIT-C, Alcohol Use Disorders Identification Test Consumption; BEDA-Q, Brief Eating Disorders in Athletes Questionnaire; CAGE-AID, Cutting Down, Annoyance by Criticism, Guilty Feeling and Eye openings Adapted to Include Drugs; GAD-7, General Anxiety Disorder-7; PHQ-9, Patient Health Questionnaire-9; PHQ-9 Q9, Question 9 of the Patient Health Questionnaire-9.
mental health provider as part of the Team USA Sports Medicine Program within 48 hours of SMHAT-1 completion. In addition, Question 9 of the Patient Health Questionnaire-9 (PHQ-9 Q9, assesses for the presence of suicidal thoughts) was scored and athletes that screened positive were contacted by a mental health provider within 20 min of submitting the health history questionnaire and were provided with appropriate care.

Statistical analysis
Descriptive statistics were computed and differences in each questionnaire between male and female (sex), Olympic and Paralympic (games), and Summer and Winter (season) athletes were tested by general linear models. Next, confusion matrices were constructed for all athletes, as well as by sex, games and season. The FNR (percentage of athletes scoring <17 on the APSQ but >threshold on one or more subsequent questionnaires) was computed for each confusion matrix. Next, logistic regression models were computed using a binary predictor variable (17 >APSQ ≥17) and a binary outcome (specific threshold >subsequent questionnaire ≥specific threshold) for all athletes and then separately for each level of sex, games and season. While multiple observations for some athletes were present in the data, the degree of dependence did not warrant mixed-effects generalised linear models as the fit of these models was singular, suggesting little variance was accounted for by this strict lack of independence. We, therefore, opted to continue using simple logistic regressions. The AUC of the ROC curves was subsequently computed for each model. Finally, we computed separate logistic regression models using cut points from 10 to 50 and extracted the APSQ threshold that maximised the AUC of the ROC for each subsequent questionnaire. All analyses were completed using R Statistical Software, and the alpha level was set at a p value of <0.05 for all inferential statistics. Additionally, we calculated post hoc power analyses for our logistic and linear regression models to provide additional context to the results presented here.

RESULTS
One thousand sixty-six athletes completed the APSQ and all of the subsequent questionnaires. The sample consisted of 518 men (Summer Olympics, n=322; Winter Olympics, n=140; Summer Paralympics, n=6; and Winter Paralympics, n=50) and 548 women (Summer Olympics, n=355; Winter Olympics, n=152; Summer Paralympics, n=26; and Winter Paralympics, n=15) from 51 sports (Summer Olympics, n=28; Winter Olympics, n=9; Summer Paralympics, n=8; and Winter Paralympics, n=6). The greatest number of athletes were positively screened on the AUDIT-C and the least on the CAGE-AID (figure 1).

Comparison by sex, season and games
When considering all athletes, APSQ scores ranged from 10 to 35. Female athletes had greater APSQ (p<0.001), GAD-7 (p<0.001), PHQ-9 (p<0.001) and BEDA-Q (p<0.001) scores and lower AUDIT-C (p<0.001) scores compared with male athletes. Paralympic athletes did not statistically differ from Olympic athletes on any scale. Winter athletes did not statistically differ from Summer athletes in APSQ score (p=0.432) but scored significantly lower on the GAD-7 (p<0.001), PHQ-9 (p<0.001), PHQ-9 Q9 (p<0.001), ASSQ (p=0.008) and BEDA-Q (p<0.001), but significantly higher on AUDIT-C (p<0.001) compared with Summer athletes (table 1 and figure 2).

False-negative rates
The FNR for athletes who were positively screened on a subsequent questionnaire with an APSQ score of <17 was between 4.8% (PHQ-9) and 66.7% (BEDA-Q) (table 2). When considering
athletes who did not positively screen on the APSQ but did so on any subsequent questionnaire, the global FNR of the APSQ was 67.4%. As shown in table 2, women had a lower FNR than men for all subsequent questionnaires, except for the PHQ-9, wherein men had an FNR of 0%. Similarly, Paralympic athletes had a lower FNR than Olympic athletes for all subsequent questionnaires and multiple instances of an FNR of 0%. Regarding PHQ-9 Q9 for all athletes, we observed an FNR of 6.7%.

Specificity and sensitivity
The greatest and lowest AUC of the ROC curve for any subcategory of any subsequent questionnaire using a threshold of APSQ score of ≥17 was 0.84 (PHQ-9 and GAD-7) and 0.34 (CAGE-AID) for All/Olympic athletes and Paralympic athletes, respectively (table 3). The average AUC of the ROC curve for the GAD-7 and PHQ-9 using a threshold of APSQ score of ≥17 was 0.82 and 0.81, respectively. An APSQ score of ≥17 threshold was a significant predictor of all subsequent questionnaires except CAGE-AID for all athletes (p=0.08), including for men (p=0.197) and women (p=0.151) when analysed separately. An APSQ score of ≥17 threshold was also not predictive of a positively screen score on CAGE-AID for Olympic athletes (p=0.085) or Summer athletes (p=0.787) when analysed separately, nor of positively screened scores on the AUDIT-C (p=0.352) or PHQ-9 (p=0.087) for Paralympic athletes and Winter athletes, respectively. All other models demonstrated a significant association between an APSQ score of ≥17 threshold and binary outcome on the subsequent questionnaire (there were insufficient data to test the association between the APSQ and having a positive screen on multiple subsequent questionnaires; see table 3).

Recalculating the APSQ threshold
The lowest optimised threshold for all athletes for the APSQ to predict a positively screened score for one of the subsequent questionnaires was determined to be ≥11 (table 4).

False-positive rates
Owing to the relatively high FNR observed, post hoc analyses were completed to evaluate the effect of removing the APSQ from the SMHAT-1 entirely and completing only the subsequent questionnaires. Specifically, we calculated the number of athletes who would exceed the APSQ score of ≥17 but would not exceed the threshold on any subsequent questionnaires (and thus, according to the current SMHAT-1 framework, be recommended for additional monitoring). As a result, only 7 of 1066 athletes (0.7%) were positively screened on the APSQ but no other subsequent questionnaire. However, because of the high number of athletes positively screened on the BEDA-Q, we also assessed how many athletes would be missed for additional monitoring if they took only the GAD-7, PHQ-9, ASSQ, AUDIT-C and CAGE-AID. In this case, 96 athletes would have been positively screened by the APSQ but no other subsequent questionnaire.

Post hoc power analyses
We calculated post hoc power analyses using our observed effect sizes; a full accounting of these analyses are available in online...
<table>
<thead>
<tr>
<th>All athletes</th>
<th>Sex</th>
<th>Games</th>
<th>Season</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Olympic</td>
<td>Summer</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>Paralympic</td>
<td>Winter</td>
</tr>
<tr>
<td>APSQ score</td>
<td>APSQ score</td>
<td>APSQ score</td>
<td>APSQ score</td>
</tr>
<tr>
<td>&lt;17</td>
<td>≥17</td>
<td>FNR (%)</td>
<td>&lt;17</td>
</tr>
<tr>
<td>GAD-7</td>
<td>&lt;10</td>
<td>750</td>
<td>276</td>
</tr>
<tr>
<td>≥10</td>
<td>2</td>
<td>38</td>
<td>1</td>
</tr>
<tr>
<td>PHQ-9</td>
<td>&lt;10</td>
<td>751</td>
<td>294</td>
</tr>
<tr>
<td>≥10</td>
<td>1</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>PHQ-9 Q9</td>
<td>&lt;1</td>
<td>745</td>
<td>299</td>
</tr>
<tr>
<td>≥1</td>
<td>1</td>
<td>14</td>
<td>1</td>
</tr>
<tr>
<td>ASSQ</td>
<td>&lt;10</td>
<td>685</td>
<td>209</td>
</tr>
<tr>
<td>≥10</td>
<td>67</td>
<td>105</td>
<td>40</td>
</tr>
<tr>
<td>AUDIT-C</td>
<td>&lt;10</td>
<td>545</td>
<td>174</td>
</tr>
<tr>
<td>≥10</td>
<td>207</td>
<td>140</td>
<td>103</td>
</tr>
<tr>
<td>CAGE-AID</td>
<td>&lt;10</td>
<td>147</td>
<td>308</td>
</tr>
<tr>
<td>≥10</td>
<td>5</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>BEDA-Q</td>
<td>&lt;10</td>
<td>866</td>
<td>23</td>
</tr>
<tr>
<td>≥10</td>
<td>582</td>
<td>291</td>
<td>300</td>
</tr>
</tbody>
</table>

APSQ, Athlete Psychological Strain Questionnaire; ASSQ, Athlete Sleep Screening Questionnaire; AUDIT-C, Alcohol Use Disorders Identification Test Consumption; BEDA-Q, Brief Eating Disorders in Athletes Questionnaire; CAGE-AID, Cutting Down, Annoyance by Criticism, Guilty Feeling and Eye Openings Adapted to Include Drugs; FNR, false-negative rate; GAD-7, General Anxiety Disorder-7; PHQ-9, Patient Health Questionnaire-9; PHQ-9 Q9, Question 9 of the Patient Health Questionnaire-9.
slightly more than the 23.2% of athletes previously reported.12 concerns. In this analysis of 1066 Olympic and Paralympic proposed to identify athletes potentially at risk of mental health questionnaires within the SMHAT-
APSQ in predicting outcomes of the subsequent question-
DISCUSSION
hoc power calculation suggested a power of <0.80.

demonstrated a statistically significant difference when the post hoc power calculation included all models, regardless of whether a significant effect of sex, games or season was observed. With regard to our linear models comparing SMHAT-1 scores by sex, games and season (table 1), we found that only ASSQ by season (power=0.74) demonstrated a statistically significant difference when the post hoc power calculation suggested a power of <0.80.

**DISCUSSION**

The present study is among the first to analyse the efficacy of the APSQ in predicting outcomes of the subsequent questionnaires within the SMHAT-1, a novel screening tool that has been proposed to identify athletes potentially at risk of mental health concerns. In this analysis of 1066 Olympic and Paralympic athletes, 29.5% of athletes screened positively on the APSQ, slightly more than the 23.2% of athletes previously reported.12

We further demonstrated that the current recommendations for an APSQ≥17 threshold results in an FNR on subsequent SMHAT-1 screening questionnaires between 4.8% and 66.7%, which tended to be higher than those previously published.1 However, we also demonstrated that a threshold of ≥17 results in a reasonably high AUC of ROC curves (0.42–0.84) and a significant ability to predict a score that would have resulted in a positive screen on one of the subsequent questionnaires. Thus, for most subsequent questionnaires, an APSQ score of ≥17 results in empirically maximising both the sensitivity and specificity of predictions.

Additionally, we demonstrated clinically meaningful FNRs for the APSQ, greater than those previously reported, particularly for the PHQ-9 and GAD-7.1 Recently, Mountjoy and colleagues evaluated Canadian collegiate athletes and demonstrated an alarmingly high presence of symptoms associated with anxiety (30%), depression (26%), sleep disturbance (39%), alcohol misuse (55%), drug use (10%) and disordered eating (83%)14; however, given the FNR in our research, the work of Mountjoy et al may in fact be underestimating the presence of potential mental health concerns and thus the number of athletes that require additional follow-up.

In our sample, female athletes tended to score higher on the APSQ, GAD-7 and PHQ-9 compared with male athletes, consistent with previous findings.12 14–17 Some preliminary data also suggest that Paralympic and Winter sport athletes experience a greater degree of psychological distress,17 which supports our

### Table 3
Odds of being positively screened on a subsequent questionnaire if APSQ score of ≥17 by sex, games and season

<table>
<thead>
<tr>
<th></th>
<th>All athletes</th>
<th>Sex</th>
<th>Games</th>
<th>Season</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Odds</td>
<td>AUC</td>
<td>Odds</td>
<td>AUC</td>
</tr>
<tr>
<td>GAD-7</td>
<td>51.6*</td>
<td>0.84</td>
<td>18.5*</td>
<td>0.81</td>
</tr>
<tr>
<td>PHQ-9</td>
<td>51.0*</td>
<td>0.84</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>PHQ-9 Q9</td>
<td>35.0*</td>
<td>0.82</td>
<td>18.5*</td>
<td>0.81</td>
</tr>
<tr>
<td>ASSQ</td>
<td>5.1*</td>
<td>0.69</td>
<td>5.3*</td>
<td>0.67</td>
</tr>
<tr>
<td>AUDIT-C</td>
<td>2.1*</td>
<td>0.42</td>
<td>2.9*</td>
<td>0.42</td>
</tr>
<tr>
<td>CAGE-AID</td>
<td>2.9</td>
<td>0.63</td>
<td>2.7</td>
<td>0.34</td>
</tr>
<tr>
<td>BEDA-Q</td>
<td>18.8*</td>
<td>0.65</td>
<td>12.5*</td>
<td>0.69</td>
</tr>
</tbody>
</table>

Note: Odds are exponentiated log odds from generalised linear model (GLM). Odds and AUC are not reported for instances wherein a threshold of APSQ score of >17 created perfect prediction (see table 2).

*Significant predictor (p<0.05).

APSQ, Athlete Psychological Strain Questionnaire; ASSQ, Athlete Sleep Screening Questionnaire; AUC, area under the curve; AUDIT-C, Alcohol Use Disorders Identification Test Consumption; BEDA-Q, Brief Eating Disorders in Athletes Questionnaire; CAGE-AID, Cutting Down, Annnoyance by Criticism, Guilty Feeling and Eye Openings Adapted to Include Drugs; GAD-7, General Anxiety Disorder-7; PHQ-9, Patient Health Questionnaire-9; PHQ-9 Q9, Question 9 of the Patient Health Questionnaire-9.

### Table 4
Optimised thresholds for APSQ in predicting a positively screen on a subsequent questionnaire by sex, games and season

<table>
<thead>
<tr>
<th></th>
<th>All athletes</th>
<th>Sex</th>
<th>Games</th>
<th>Season</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Threshold</td>
<td>AUC</td>
<td>Threshold</td>
<td>AUC</td>
</tr>
<tr>
<td>GAD-7</td>
<td>≥18</td>
<td>0.86</td>
<td>≥16</td>
<td>0.88</td>
</tr>
<tr>
<td>PHQ-9</td>
<td>≥20</td>
<td>0.89</td>
<td>≥20</td>
<td>0.95</td>
</tr>
<tr>
<td>PHQ-9 Q9</td>
<td>≥17</td>
<td>0.82</td>
<td>≥17</td>
<td>0.81</td>
</tr>
<tr>
<td>ASSQ</td>
<td>≥17</td>
<td>0.69</td>
<td>≥14</td>
<td>0.68</td>
</tr>
<tr>
<td>AUDIT-C</td>
<td>≥13</td>
<td>0.59</td>
<td>≥13</td>
<td>0.60</td>
</tr>
<tr>
<td>CAGE-AID</td>
<td>≥18</td>
<td>0.64</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>BEDA-Q</td>
<td>≥13</td>
<td>0.64</td>
<td>≥11</td>
<td>0.64</td>
</tr>
</tbody>
</table>

Note: AUC of ROC curve for BEDA-Q when modelling Olympic athletes only when using a threshold of ≥11 and ≥13. Models and therefore optimised thresholds could not be computed for some predictions due to the absence of positive cases or where models’ best threshold performed worse than an AUC of ROC curve=0.5.

APSQ, Athlete Psychological Strain Questionnaire; ASSQ, Athlete Sleep Screening Questionnaire; AUC, area under the curve; AUDIT-C, Alcohol Use Disorders Identification Test Consumption; BEDA-Q, Brief Eating Disorders in Athletes Questionnaire; CAGE-AID, Cutting Down, Annnoyance by Criticism, Guilty Feeling and Eye Openings Adapted to Include Drugs; GAD-7, General Anxiety Disorder-7; PHQ-9, Patient Health Questionnaire-9; ROC, receiver operating characteristic.
Previous work has demonstrated that including suicide screening potentially have catastrophic consequences. Incorrectly triaging an athlete at risk of self-harm and, thus, neglecting to perform a formal clinical evaluation and relevant implementation of proper treatment plans for the athlete could potentially have catastrophic consequences.

Acceptable FNRs
Most critically, a low FNR, especially in the event of just a single observation missed (as in the case of PHQ-9 Q9), would be ideal in most academic and theoretical contexts. However, it is crucial to recognise that the acceptable FNR is dependent and inversely proportional to the predicted outcome’s importance and severity. As with other physical and mental health concerns, an FNR as close to 0 as possible is highly desirable, and the more critical and severe the predicted outcome, the more important this becomes. In the context of mental health, this would most obviously apply to PHQ-9 Q9, as we know that suicidal ideation can be as high as 17.4% in some populations, and suicide contributes substantially to all-cause mortality in elite athletes.

Previous work has demonstrated that including suicide screening does not increase the likelihood of those ideations. Conversely, incorrectly triaging an athlete at risk of self-harm and, thus, neglecting to perform a formal clinical evaluation and relevant implementation of proper treatment plans for the athlete could potentially have catastrophic consequences.

Clinical implications and recommended changes to the SMHAT-1
The SMHAT-1 is in its infancy, having been devised and deployed for use in athletics settings for less than 2 years (released in 2021). Therefore, it is expected that this tool will be modified as additional data are gathered to inform proper clinical decisions. Indeed, we believe the SMHAT-1 is a critical component of our health history screening for all Olympic and Paralympic athletes and will continue to champion its use. However, given the wide range of FNRs (4.8%–66.7%) demonstrated here, despite the otherwise acceptable performance of the APSQ score of ≥17 threshold in a purely quantitative sense, we suggest that the APSQ should not be used as a stand-alone initial triage step in the use of the SMHAT-1 in athletes; rather, the combination of steps 1 and 2 of the SMHAT-1 as an initial triage step prior to referral of athletes to a mental health provider may best serve our athlete populations. In this case, athletes could be positively screened on subsequent questionnaires—including, critically, the PHQ-9 Q9—for clinical assessment and care without needing to be positively screened on the APSQ. Additionally, those athletes who would positively screen on the APSQ but not on subsequent questionnaires (ie, in our sample, when not including the BEDA-Q, n=93) and require follow-up and additional monitoring would not be missed. Alternatively, it may be that the time required for athletes or the medical resources required for qualified professional clinicians to review and efficiently contact athletes would be too great. In this case, we recommend that at least the APSQ be adapted for specific use as a triage tool in the SMHAT-1 by including an 11th question on suicide risk (eg, the inclusion of PHQ-9 Q9). In this case, the question with the most significant consequence is included as part of the triage.

Limitations
Despite the large sample size and robust analysis and subanalyses of the SMHAT-1 in our current study, several limitations should be acknowledged. First, these data were collected after the start of and during the SARS-CoV-2 global pandemic, at which time the Tokyo 2020 Games were delayed, resulting in many athletes having to adjust to alternative training and competition schedules. The Beijing 2022 Games also introduced additional stressors for athletes that may not be present during a non-Games year, both related and unrelated to pandemic adjustments. These concerns likely influenced, to some degree, the prevalence of positive SMHAT-1 screens observed here. Moreover, these data, much like the original APSQ-validation studies, consist of athletes from a single country. It is acknowledged that this dataset is more diverse regarding sex, sport and seasons. However, additional data from other countries, especially countries with varying mental health educational systems, mental healthcare infrastructure and global sociocultural differences, should be analysed to confirm our results. Relatedly, only a small number of athletes were positively screened on subsequent questionnaires, especially on the PHQ-9 Q9. This small number of positive cases may produce biased estimates and unreliable (high or low) FNRs (see PHQ-9 Q9 in Winter athletes, table 2).

We also acknowledge that more specific analyses of Paralympic athletes are required, accounting for category and degree of impairments. Regrettably, we do not have the requisite sample size to conduct this analysis, but we strongly encourage this in future SMHAT-1 studies. Although we included all available athletes in these analyses, we also acknowledge that the sample size may be underpowered, particularly for some of our subgroup analyses. To investigate this further, we calculated post hoc power analyses and reported those values in online supplemental material 1. However, we also recognise and acknowledge that post hoc power analyses have substantial statistical issues and thus cannot necessarily be relied on to confirm adequate sample size for all analyses and comparisons. For example, the statistically significant differences in ASSQ score by season had a post hoc power (1−β) of <0.80, and thus these differences should therefore be interpreted with caution, although the true effect size in the population may not be represented by our observed effect size, and thus these power analyses may be misleading. We therefore further encourage other National Olympic and Paralympic Committees to continue collaborating and aggregating data to better understand how the SMHAT-1 can be improved for the sake of athletes’ mental health and well-being.

CONCLUSIONS
In conclusion, based on our findings, we recommend having athletes complete the APSQ and all subsequent questionnaires of the SMHAT rather than using the APSQ as a screening test. If only the APSQ is used as a screening test in time-limited or resource-limited settings, we recommend adding PHQ-9 Q9 to the APSQ to ensure those at risk to themselves are identified. These results are presented to enhance the effectiveness of the SMHAT-1, and we continue to advocate for the inclusion of the SMHAT-1 for mental health screening in elite athletes.

Twitter Travis Anderson @travaldinho

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Contributors TA was responsible for data analysis, data visualisation and data interpretation and was the lead author. WMA, JDB, ALB, ATD and JTF were responsible for the study design, data collection and data interpretation. All authors were responsible for the critical review and editing of the manuscript. JDB and ALB provided domain expertise throughout the project. WMA is the guarantor.

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Original research

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Power Analysis

The following code was used to determine the power analysis for each logistic regression model.

#GAD7 All Athletes

## Call:
## glm(formula = anxiety_threshold ~ apsq_threshold, family = binomial, 
##     data = model.df)

## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.5079  -0.5079   -0.0730  -0.0730   3.4437

## Coefficients:
##                Estimate Std. Error z value Pr(>|z|)
## (Intercept)     -5.9269     0.7080  -8.372  < 2e-16 ***
## apsq_threshold   3.9441     0.7288   5.412 6.24e-08 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

## (Dispersion parameter for binomial family taken to be 1)

## Null deviance: 341.10  on 1065  degrees of freedom
## Residual deviance: 259.41  on 1064  degrees of freedom
## (3076 observations deleted due to missingness)
## AIC: 263.41

## Number of Fisher Scoring iterations: 8

## Power for logistic regression

## p0 p1 beta0 beta1 n alpha power
## 0.002659575 0.1210191 -5.926926 3.944111 1066 0.05 0.9962332

## URL: http://psychstat.org/logistic

#PHQ9 All Athletes

## Call:
## glm(formula = depression_threshold ~ apsq_threshold, family = binomial, 
##     data = model.df)

## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.3628  -0.3628  -0.0516  -0.0516   3.6394
## Coefficients:

|                      | Estimate | Std. Error | z value | Pr(>|z|)  |
|----------------------|----------|------------|---------|-----------|
| (Intercept)          | -6.621   | 1.001      | -6.617  | 3.66e-11 *** |
| apsq_threshold       | 3.934    | 1.027      | 3.830   | 0.00128 *** |

---

Signif. codes:  
0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

Null deviance: 206.52  on 1065  degrees of freedom
Residual deviance: 164.09  on 1064  degrees of freedom
(3076 observations deleted due to missingness)
AIC: 168.09

Number of Fisher Scoring iterations: 9

## apsq_threshold

51.08844

## Power for logistic regression

<table>
<thead>
<tr>
<th>p0</th>
<th>p1</th>
<th>beta0</th>
<th>beta1</th>
<th>n</th>
<th>alpha</th>
<th>power</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.001329787</td>
<td>0.06369427</td>
<td>-6.621406</td>
<td>3.933558</td>
<td>1066</td>
<td>0.05</td>
<td>0.9054437</td>
</tr>
</tbody>
</table>

URL: http://psychstat.org/logistic

#PHQ9 Q9 All Athletes

## Call:
glm(formula = depression_9_threshold ~ apsq_threshold, family = binomial, data = model.df)

## Deviance Residuals:

<table>
<thead>
<tr>
<th>Min</th>
<th>1Q</th>
<th>Median</th>
<th>3Q</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.3020</td>
<td>-0.3020</td>
<td>-0.0516</td>
<td>-0.0516</td>
<td>3.6394</td>
</tr>
</tbody>
</table>

## Coefficients:

|                      | Estimate | Std. Error | z value | Pr(>|z|)  |
|----------------------|----------|------------|---------|-----------|
| (Intercept)          | -6.621   | 1.001      | -6.617  | 3.66e-11 *** |
| apsq_threshold       | 3.557    | 1.037      | 3.429   | 0.000607 *** |

---

Signif. codes:  
0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

Null deviance: 157.7  on 1065  degrees of freedom
Residual deviance: 129.7  on 1064  degrees of freedom
(3076 observations deleted due to missingness)
AIC: 133.7
## Number of Fisher Scoring iterations: 9

## apsq_threshold
##  35.04667

## Power for logistic regression
##
##       p0         p1     beta0    beta1    n alpha     power
##  0.001329787 0.04458599 -6.621406 3.556681 1066  0.05 0.8381283

## URL: http://psychstat.org/logistic

#ASSQ All Athletes

## Call:
## glm(formula = sleep_threshold ~ apsq_threshold, family = binomial,
##     data = model.df)

## Deviance Residuals:
##    Min       1Q   Median       3Q      Max
## -0.9023  -0.4320  -0.4320  -0.4320   2.1991

## Coefficients:
##                Estimate Std. Error z value Pr(>|z|)
## (Intercept)   -2.3247     0.1280  -18.16   <2e-16 ***
## apsq_threshold 1.6364     0.1752    9.34   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

## (Dispersion parameter for binomial family taken to be 1)

## Null deviance: 942.14  on 1065  degrees of freedom
## Residual deviance: 852.05  on 1064  degrees of freedom
## (3076 observations deleted due to missingness)
## AIC: 856.05

## Number of Fisher Scoring iterations: 5

## apsq_threshold
##  5.136399

## Power for logistic regression
##
##       p0         p1     beta0    beta1    n alpha     power
##  0.08909574 0.3343949 -2.324726 1.636352 1066  0.05     1

## URL: http://psychstat.org/logistic

#Alcohol All Athletes
Call: glm(formula = alcohol_threshold ~ apsq_threshold, family = binomial, data = model.df)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-1.0866  -0.8024  -0.8024   1.2710   1.6062

Coefficients:
                   Estimate Std. Error z value Pr(>|z|)
(Intercept) -0.96807    0.08164 -11.857  < 2e-16 ***
apsq_threshold  0.75065    0.13984   5.368 7.97e-08 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

Null deviance: 1345.2  on 1065  degrees of freedom
Residual deviance: 1316.6  on 1064  degrees of freedom
(3076 observations deleted due to missingness)
AIC: 1320.6

Number of Fisher Scoring iterations: 4

Power for logistic regression

        p0   p1  beta0  beta1    n alpha      power
0.275266 0.4458599 -0.968067 0.7506541 1066 0.05 0.9999269

URL: http://psychstat.org/logistic

Call: glm(formula = drug_threshold ~ apsq_threshold, family = binomial, data = model.df)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-0.1964  -0.1964  -0.1155  -0.1155   3.1665

Coefficients:
                   Estimate Std. Error z value Pr(>|z|)
(Intercept)     -5.0066     0.4486 -11.160   <2e-16 ***
apsq_threshold  1.0683     0.6093  1.753     0.0795 .
---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## (Dispersion parameter for binomial family taken to be 1)
##
## Null deviance: 122.51  on 1065  degrees of freedom
## Residual deviance: 119.48  on 1064  degrees of freedom
## (3076 observations deleted due to missingness)
## AIC: 123.48
##
## Number of Fisher Scoring iterations: 7

## apsq_threshold
##   2.910389

## Power for logistic regression
##
## p0     p1    beta0    beta1   n   alpha power
## 0.006648936 0.01910828 -5.006627 1.068287 1066  0.05  0.4066793

## URL: http://psychstat.org/logistic

#Food All Athletes

## Call:
## glm(formula = food_threshold ~ apsq_threshold, family = binomial,
##     data = model.df)
##
## Deviance Residuals:
##    Min      1Q  Median      3Q     Max
## -2.286  -1.014  -1.014   1.350   1.350
##
## Coefficients:
##                Estimate Std. Error z value Pr(>|z|)
## (Intercept)     -0.3974     0.0536  -7.414 1.22e-13 ***
## apsq_threshold   2.9352     0.2231  13.155  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## (Dispersion parameter for binomial family taken to be 1)
##
## Null deviance: 2442.5  on 1761  degrees of freedom
## Residual deviance: 2115.8  on 1760  degrees of freedom
## (2380 observations deleted due to missingness)
## AIC: 2119.8
##
## Number of Fisher Scoring iterations: 5

## apsq_threshold
##   18.82609

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## Power for logistic regression
##
##            p0        p1      beta0    beta1    n alpha power
##     0.4019337 0.9267516 -0.3974145 2.935244 1762  0.05     1
##
## URL: http://psychstat.org/logistic

#Males Only

#GAD7 Male Athletes

## Call:
## glm(formula = anxiety_threshold ~ apsq_threshold, family = binomial,
##     data = model.df.males)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.2995  -0.0704  -0.0704  -0.0704   3.4645
##
## Coefficients:
##                Estimate Std. Error z value  Pr(>|z|)
## (Intercept)      -5.999      1.001  -5.992 2.07e-09 ***
## apsq_threshold    2.917      1.101   2.650  0.00804 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
## Null deviance: 65.429  on 517  degrees of freedom
## Residual deviance: 55.045  on 516  degrees of freedom
## (1504 observations deleted due to missingness)
## AIC: 59.045
##
## Number of Fisher Scoring iterations: 8
##
## apsq_threshold
##       18.48624
##
## Power for logistic regression
##
##            p0        p1      beta0    beta1    n alpha power
##     0.002475248 0.04385965 -5.998937 2.917027 518  0.05 0.6205778
##
## URL: http://psychstat.org/logistic

#PHQ9 Male Athletes

## Call:
## glm(formula = depression_threshold ~ apsq_threshold, family = binomial,
## data = model.df.males)
##
## Deviance Residuals:
##    Min      1Q  Median      3Q     Max
##  -0.29950 -0.00002 -0.00002 -0.00002  2.50070
##
## Coefficients:
##                        Estimate  Std. Error    z value  Pr(>|z|)
## (Intercept)             -22.57     2397.85    -0.009      0.992
## apsq_threshold          19.48     2397.85     0.008      0.994
##
## (Dispersion parameter for binomial family taken to be 1)
##
## Null deviance: 56.357  on 517  degrees of freedom
## Residual deviance: 41.045  on 516  degrees of freedom
## (1504 observations deleted due to missingness)
## AIC: 45.045
##
## Number of Fisher Scoring iterations: 21
## apsq_threshold
##    289642671
##
## Power for logistic regression
##
##    p0       p1     beta0    beta1    n      alpha    power
## 1.583729e-10 0.04385965 -22.56607 19.48416 518 0.05 0.05000178
##
## URL: http://psychstat.org/logistic

#PHQ9 Q9 Male Athletes

## Call:
## glm(formula = depression_9_threshold ~ apsq_threshold, family = binomial,
##     data = model.df.males)
##
## Deviance Residuals:
##    Min      1Q  Median      3Q     Max
##  -0.2995 -0.0704 -0.0704 -0.0704  3.4645
##
## Coefficients:
##                        Estimate  Std. Error     z value  Pr(>|z|)
## (Intercept)             -5.999      1.001    -5.992  2.07e-09 ***
## apsq_threshold          2.917      1.101      2.650  0.00804 **
##
## (Dispersion parameter for binomial family taken to be 1)
##
## Null deviance: 65.429  on 517  degrees of freedom
## Residual deviance: 55.045 on 516 degrees of freedom
## (1504 observations deleted due to missingness)
## AIC: 59.045
## Number of Fisher Scoring iterations: 8

## apsq_threshold
##       18.48624

## Power for logistic regression
##
##              p0         p1     beta0    beta1   n alpha     power
##     0.002475248 0.04385965 -5.998937 2.917027 518  0.05 0.6205778

## URL: http://psychstat.org/logistic

#ASSQ Male Athletes

## Call:
glm(formula = sleep_threshold ~ apsq_threshold, family = binomial, data = model.df.males)

## Deviance Residuals:
##     Min   1Q Median   3Q   Max
## -0.9587 -0.4566 -0.4566 -0.4566 2.1506

## Coefficients:
## Estimate Std. Error z value Pr(>|z|)
## (Intercept) -2.2083     0.1666 -13.258  < 2e-16 ***
## apsq_threshold 1.6693     0.2558   6.525 6.78e-11 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

## (Dispersion parameter for binomial family taken to be 1)

## Null deviance: 452.57 on 517 degrees of freedom
## Residual deviance: 410.95 on 516 degrees of freedom
## (1504 observations deleted due to missingness)
## AIC: 414.95

## Number of Fisher Scoring iterations: 4

## apsq_threshold
##       5.308333

## Power for logistic regression
##
##              p0         p1     beta0    beta1   n alpha     power
##     0.0990099 0.3684211 -2.208274 1.669278 518  0.05 0.9999994
# Alcohol Male Athletes

```r
# Call:
glm(formula = alcohol_threshold ~ apsq_threshold, family = binomial,
data = model.df.males)

# Deviance Residuals:
## Min  1Q  Median  3Q  Max
## -1.0891 -0.7672 -0.7672 1.2684 1.6533

# Coefficients:
##             Estimate Std. Error z value Pr(>|z|)
## (Intercept) -1.0724     0.1142  -9.394  < 2e-16 ***
## apsq_threshold  0.8611     0.2203   3.909  9.25e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

# (Dispersion parameter for binomial family taken to be 1)

# Null deviance: 630.46  on 517  degrees of freedom
# Residual deviance: 615.48  on 516  degrees of freedom
#   (1504 observations deleted due to missingness)
# AIC: 619.48

# Number of Fisher Scoring iterations: 4

# apsq_threshold
##  2.365696

# Power for logistic regression

# p0 p1 beta0 beta1 n alpha power
## 0.2549505 0.4473684 -1.072381 0.8610722 518 0.05 0.9950865
```

# Drug Male Athletes

```r
# Call:
glm(formula = drug_threshold ~ apsq_threshold, family = binomial,
data = model.df.males)

# Deviance Residuals:
## Min  1Q  Median  3Q  Max
## -0.2309 -0.1411 -0.1411 -0.1411  3.0381
```

---

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### Coefficients:

|              | Estimate | Std. Error | z value | Pr(>|z|) |
|--------------|----------|------------|---------|----------|
| (Intercept)  | -4.6052  | 0.5025     | -9.165  | <2e-16 **|
| apsq_threshold | 0.9943   | 0.7713     | 1.289   | 0.197    |

---

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

Null deviance: 74.162 on 517 degrees of freedom
Residual deviance: 72.627 on 516 degrees of freedom

(1504 observations deleted due to missingness)

Number of Fisher Scoring iterations: 7

## Power for logistic regression

\[
p_0 \quad p_1 \quad \beta_0 \quad \beta_1 \quad n \quad \alpha \quad \text{power}
\]

\[
0.00990099 \quad 0.02631579 \quad -4.60517 \quad 0.9942523 \quad 518 \quad 0.05 \quad 0.2705362
\]

URL: [http://psychstat.org/logistic](http://psychstat.org/logistic)

### Food Male Athletes

Call:

```r
glm(formula = food_threshold ~ apsq_threshold, family = binomial, data = model.df.males)
```

Deviance Residuals:

```
Min      1Q  Median      3Q     Max
-2.122  -1.019  -1.019   1.345   1.345
```

Coefficients:

|              | Estimate | Std. Error | z value | Pr(>|z|) |
|--------------|----------|------------|---------|----------|
| (Intercept)  | -0.3852  | 0.0748     | -5.148  | 2.63e-07 *** |
| apsq_threshold | 2.52533 | 0.31421 | 8.037   | 9.21e-16 *** |

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

Null deviance: 1182.2 on 854 degrees of freedom
Residual deviance: 1077.0 on 853 degrees of freedom

(1167 observations deleted due to missingness)

AIC: 1081
### GAD7 Female Athletes

```r
## Number of Fisher Scoring iterations: 4
## apsq_threshold
##       12.495
## Power for logistic regression
## ## p0    p1    beta0 beta1   n alpha    power
## 0.4048583 0.8947368 -0.3852624 2.525329 855 0.05     1
## URL: http://psychstat.org/logistic
```

### PHQ9 Female Athletes

```r
## Number of Fisher Scoring iterations: 8
## apsq_threshold
##       68.56886
## Power for logistic regression
## ## p0    p1    beta0 beta1   n alpha    power
## 0.002873563 0.165 -5.849325 4.227839 548 0.05 0.9597487
## URL: http://psychstat.org/logistic
```
## Call:
## glm(formula = depression_threshold ~ apsq_threshold, family = binomial, 
##     data = model.df.females)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.3949  -0.3949  -0.0759  -0.0759   3.4212
##
## Coefficients:
##                Estimate Std. Error z value Pr(>|z|)
## (Intercept)      -5.849      1.001  -5.841 5.18e-09 ***
## apsq_threshold    3.337      1.037   3.219  0.00129 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
## Null deviance: 144.61  on 547  degrees of freedom
## Residual deviance: 120.26  on 546  degrees of freedom
##   (1572 observations deleted due to missingness)
## AIC: 124.26
##
## Number of Fisher Scoring iterations: 8

## Coefficients:
##                Estimate Std. Error z value Pr(>|z|)
## (Intercept)      -21.57    1567.02  -0.014    0.989
## apsq_threshold    18.51    1567.02   0.012    0.991

## Power for logistic regression
##
## URL: http://psychstat.org/logistic

#PHQ9 Q9 Female Athletes

## Call:
## glm(formula = depression_9_threshold ~ apsq_threshold, family = binomial, 
##     data = model.df.females)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.30346  -0.30346  -0.00003  -0.00003   2.49042
##
## Coefficients:
##                Estimate Std. Error z value Pr(>|z|)
## (Intercept)     -5.8491   1567.02  -0.003    0.999
## apsq_threshold   18.5151   1567.02   0.012    0.991
## (Dispersion parameter for binomial family taken to be 1)
##
## Null deviance: 91.814  on 547 degrees of freedom  
## Residual deviance: 73.408  on 546 degrees of freedom  
## (1572 observations deleted due to missingness)  
## AIC: 77.408
##
## Number of Fisher Scoring iterations: 20

## apsq_threshold
## 109454519

## Power for logistic regression
##
## p0    p1    beta0    beta1    n    alpha    power
## 4.305023e-10 0.045  -21.56607  18.51102  548  0.05    0.05000463

## URL: http://psychstat.org/logistic

### ASSQ Female Athletes

## Call:
## glm(formula = sleep_threshold ~ apsq_threshold, family = binomial,  
##     data = model.df.females)

## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.8699  -0.5189  -0.4019  -0.4019   2.2611

## Coefficients:
##                Estimate Std. Error z value Pr(>|z|)
## (Intercept)  -2.4756     0.2004  -12.355  < 2e-16 ***
## apsq_threshold 1.6988     0.2516    6.751 1.47e-11 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

## (Dispersion parameter for binomial family taken to be 1)
##
## Null deviance: 489.50  on 547 degrees of freedom  
## Residual deviance: 439.11  on 546 degrees of freedom  
## (1572 observations deleted due to missingness)  
## AIC: 443.11
##
## Number of Fisher Scoring iterations: 5

## apsq_threshold
## 5.467153

## Power for logistic regression
##
# Alcohol Female Athletes

```r
# Call:  
# glm(formula = alcohol_threshold ~ apsq_threshold, family = binomial,  
#     data = model.df.females)  
#  
## Deviance Residuals:  
##     Min      1Q  Median      3Q     Max
## -1.0852 -0.8427 -0.8427  1.2725  1.5542
##  
## Coefficients:  
##                Estimate Std. Error z value Pr(>|z|)
## (Intercept)    -0.8528     0.1171  -7.282 3.29e-13 ***
## apsq_threshold  0.6319     0.1843   3.429 0.000606 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##  
## (Dispersion parameter for binomial family taken to be 1)
##  
##     Null deviance: 711.08  on 547  degrees of freedom
##    Residual deviance: 699.32  on 546  degrees of freedom
## (1572 observations deleted due to missingness)
## AIC: 703.32
##  
## Number of Fisher Scoring iterations: 4
##  
## apsq_threshold
##        1.88115
```

# Drug Female Athletes

```r
# Call:  
# glm(formula = drug_threshold ~ apsq_threshold, family = binomial,  
#     data = model.df.females)  
#  
## Deviance Residuals:  
##     Min      1Q  Median      3Q     Max
## -1.0852 -0.8427 -0.8427  1.2725  1.5542
##  
## Coefficients:  
##                Estimate Std. Error z value Pr(>|z|)
## (Intercept)    -0.8528     0.1171  -7.282 3.29e-13 ***
## apsq_threshold  0.6319     0.1843   3.429 0.000606 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##  
## (Dispersion parameter for binomial family taken to be 1)
##  
##     Null deviance: 711.08  on 547  degrees of freedom
##    Residual deviance: 699.32  on 546  degrees of freedom
## (1572 observations deleted due to missingness)
## AIC: 703.32
##  
## Number of Fisher Scoring iterations: 4
##  
## apsq_threshold
##        1.88115
```
## Coefficients:  
|                | Estimate | Std. Error | z value | Pr(>|z|) |
|----------------|----------|------------|---------|----------|
| (Intercept)    | -5.849   | 1.001      | -5.841  | 5.18e-09 |
| apsq_threshold | 1.665    | 1.158      | 1.437   | 0.151    |

---

Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

Null deviance: 47.331  on 547 degrees of freedom
Residual deviance: 44.855  on 546 degrees of freedom
(1572 observations deleted due to missingness)

Number of Fisher Scoring iterations: 8

## apsq_threshold

5.284264

Power for logistic regression

<table>
<thead>
<tr>
<th>p0</th>
<th>p1</th>
<th>beta0</th>
<th>beta1</th>
<th>n</th>
<th>alpha</th>
<th>power</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.002873563</td>
<td>0.015</td>
<td>-5.849325</td>
<td>1.664733</td>
<td>548</td>
<td>0.05</td>
<td>0.2713913</td>
</tr>
</tbody>
</table>

URL: http://psychstat.org/logistic

#Food Female Athletes

## Call:

`glm(formula = food_threshold ~ apsq_threshold, family = binomial, data = model.df.females)`

## Deviance Residuals:

<table>
<thead>
<tr>
<th>Min</th>
<th>1Q</th>
<th>Median</th>
<th>3Q</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2.4085</td>
<td>-1.0089</td>
<td>0.3364</td>
<td>1.3558</td>
<td>1.3558</td>
</tr>
</tbody>
</table>

## Coefficients:  
|                | Estimate | Std. Error | z value | Pr(>|z|) |
|----------------|----------|------------|---------|----------|
| (Intercept)    | -0.41018 | 0.07681    | -5.341  | 9.27e-08 |
| apsq_threshold | 3.25403  | 0.31952    | 10.184  | < 2e-16  |

---

Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

Null deviance: 1256.0  on 906 degrees of freedom
Residual deviance: 1036.2  on 905 degrees of freedom
(1213 observations deleted due to missingness)
## AIC: 1040.2
## Number of Fisher Scoring iterations: 5
## apsq_threshold
##  25.89458
## Power for logistic regression
## p0  p1  beta0  beta1  n  alpha  power
## 0.3988685 0.945 -0.4101821 3.254034 907 0.05     1
## URL: http://psychstat.org/logistic

#GAD7 Olympic Athletes
## Call:
glm(formula = anxiety_threshold ~ apsq_threshold, family = binomial, data = model.df.olympics)
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.4776  -0.0756  -0.0756  -0.0756   3.4228
## Coefficients:
##                Estimate Std. Error z value Pr(>|z|)
## (Intercept)   -5.8551     0.7081  -8.269  < 2e-16 ***
## apsq_threshold  3.7417     0.7349   5.092 3.55e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## (Dispersion parameter for binomial family taken to be 1)
## Null deviance: 274.42  on 968  degrees of freedom
## Residual deviance: 211.37  on 967  degrees of freedom
## (2787 observations deleted due to missingness)
## AIC: 215.37
## Number of Fisher Scoring iterations: 8
## apsq_threshold
##  42.17083
## Power for logistic regression
## p0  p1  beta0  beta1  n  alpha  power
## 0.002857143 0.1078067 -5.855072 3.741729 969 0.05 0.9911636
## URL: http://psychstat.org/logistic
#PHQ9 Olympic Athletes

## Call:
glm(formula = depression_threshold ~ apsq_threshold, family = binomial, data = model.df.olympics)

## Deviance Residuals:
Min       1Q  Median       3Q      Max
-0.3388  -0.3388  -0.0535  -0.0535  3.6197

## Coefficients:
Estimate Std. Error z value Pr(>|z|)
(Intercept)   -6.550      1.001  -6.545 5.95e-11 ***
apsq_threshold   3.720      1.035   3.593 0.000327 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

Null deviance: 163.05  on 968  degrees of freedom
Residual deviance: 130.85  on 967  degrees of freedom
(2787 observations deleted due to missingness)
AIC: 134.85

Number of Fisher Scoring iterations: 9

apsq_threshold
41.27953

Power for logistic regression

        p0       p1 beta0 beta1  n alpha power
0.001428571 0.05576208 -6.549651 3.720367 969 0.05 0.8625665

URL: http://psychstat.org/logistic

#PHQ9 Q9 Olympic Athletes

## Call:
glm(formula = depression_9_threshold ~ apsq_threshold, family = binomial, data = model.df.olympics)

## Deviance Residuals:
Min       1Q  Median       3Q      Max
-0.2890  -0.2890  -0.0535  -0.0535  3.6197

## Coefficients:
Estimate Std. Error z value Pr(>|z|)
(Intercept)   -6.550      1.001  -6.545 5.95e-11 ***
## apsq_threshold    3.395      1.047   3.242  0.00119 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## (Dispersion parameter for binomial family taken to be 1)
##  Null deviance: 129.24  on 968 degrees of freedom
##  Residual deviance: 106.97  on 967 degrees of freedom
##  (2787 observations deleted due to missingness)
##  AIC: 110.97
##  Number of Fisher Scoring iterations: 9

## apsq_threshold
##       29.80233

## Power for logistic regression
##  p0         p1     beta0    beta1   n alpha    power
##  0.001428571 0.04089219 -6.549651 3.394586 969  0.05 0.791658

## URL: http://psychstat.org/logistic

#ASSQ Olympic Athletes

## Call:
## glm(formula = sleep_threshold ~ apsq_threshold, family = binomial,
##     data = model.df.olympics)

## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.9211  -0.4307  -0.4307  -0.4307   2.2018

## Coefficients:
##                Estimate Std. Error  z value Pr(>|z|)
## (Intercept)    -2.3312     0.1330 -17.524   <2e-16 ***
## apsq_threshold  1.6933     0.1847   9.166   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

## (Dispersion parameter for binomial family taken to be 1)
##  Null deviance: 851.95  on 968 degrees of freedom
##  Residual deviance: 765.79  on 967 degrees of freedom
##  (2787 observations deleted due to missingness)
##  AIC: 769.79
##  Number of Fisher Scoring iterations: 5
## apsq_threshold
##         5.4375

## Power for logistic regression
##
##            p0        p1     beta0    beta1   n alpha power
##     0.08857143 0.3457249 -2.331204 1.693319 969  0.05     1
##
## URL: http://psychstat.org/logistic

#Alcohol Olympic Athletes

##
## Call:
## glm(formula = alcohol_threshold ~ apsq_threshold, family = binomial, data = model.df.olympics)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -1.1055  -0.8007  -0.8007   1.2510   1.6085
##
## Coefficients:
##                Estimate Std. Error z value Pr(>|z|)
## (Intercept)    -0.97299    0.08472 -11.485  < 2e-16 ***
## apsq_threshold  0.80156    0.14885   5.385 7.24e-08 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
## Null deviance: 1222.2  on 968  degrees of freedom
## Residual deviance: 1193.4  on 967  degrees of freedom
## (2787 observations deleted due to missingness)
## AIC: 1197.4
##
## Number of Fisher Scoring iterations: 4
##
## apsq_threshold
##       2.229024

## Power for logistic regression
##
##            p0        p1     beta0    beta1   n alpha power
##     0.2742857 0.4572491 -0.9729861 0.8015638 969  0.05 0.9999527
##
## URL: http://psychstat.org/logistic

#Drug Olympic Athletes

##
## Call:
```r
## glm(formula = drug_threshold ~ apsq_threshold, family = binomial, 
##     data = model.df.olympics)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.2124  -0.2124  -0.1197  -0.1197   3.1438
##
## Coefficients:
##                Estimate Std. Error z value Pr(>|z|)
## (Intercept)     -4.9345     0.4488 -10.995   <2e-16 ***
## apsq_threshold   1.1541     0.6098   1.893   0.0584 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 120.40  on 968  degrees of freedom
## Residual deviance: 116.88  on 967  degrees of freedom
##   (2787 observations deleted due to missingness)
## AIC: 120.88
##
## Number of Fisher Scoring iterations: 7
##
## apsq_threshold
##        3.171103

## Power for logistic regression
##
##       p0       p1   beta0   beta1    n   alpha   power
## 0.007142857 0.02230483 -4.934474 1.154079 969  0.05 0.4595868

## URL: http://psychstat.org/logistic

# Food Olympic Athletes

## glm(formula = food_threshold ~ apsq_threshold, family = binomial, 
##     data = model.df.olympics)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -2.2584  -1.0713   0.4032   1.2873   1.2873
##
## Coefficients:
##                Estimate Std. Error z value Pr(>|z|)
## (Intercept)    -0.25480    0.05728  -4.448 8.66e-06 ***
## apsq_threshold  2.72371    0.23438  11.621  < 2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```
## (Dispersion parameter for binomial family taken to be 1)
##
## Null deviance: 2087.3 on 1507 degrees of freedom
## Residual deviance: 1845.1 on 1506 degrees of freedom
## (2248 observations deleted due to missingness)
## AIC: 1849.1
##
## Number of Fisher Scoring iterations: 5

## apsq_threshold
##      15.23669

## Power for logistic regression
##
## | p0       | p1       | beta0     | beta1     | n   | alpha | power |
##|----------|----------|-----------|-----------|-----|-------|-------|
##| 0.4366425| 0.9219331| -0.2547998| 2.723706  | 1508| 0.05  | 1     |

## URL: http://psychstat.org/logistic

#GAD7 Paralympic Athletes

## Call:
## glm(formula = anxiety_threshold ~ apsq_threshold, family = binomial,
##     data = model.df.paralympics)

## Deviance Residuals:
##      Min        1Q    Median        3Q       Max
## -0.66805  -0.66805  -0.00005  -0.00005   1.79412

## Coefficients:
##                  Estimate Std. Error   z value Pr(>|z|)
## (Intercept)       -20.57    2458.76 -0.00804    0.993
## apsq_threshold    19.18    2458.76  0.00804    0.994

## (Dispersion parameter for binomial family taken to be 1)
##
## Null deviance: 59.933 on 96 degrees of freedom
## Residual deviance: 45.036 on 95 degrees of freedom
## (289 observations deleted due to missingness)
## AIC: 49.036
##
## Number of Fisher Scoring iterations: 19

## apsq_threshold
##      213633857

## Power for logistic regression
##
## | p0         | p1      | beta0     | beta1     | n   | alpha | power |
##|------------|---------|-----------|-----------|-----|-------|-------|
##| 1.170226e-09| 0.2     | -20.56607 | 19.17977  | 97  | 0.05  | 0.05000239 |
## URL: http://psychstat.org/logistic

### PHQ9 Paralympic Athletes

```r
## Call:
glm(formula = depression_threshold ~ apsq_threshold, family = binomial, 
data = model.df.paralympics)

## Deviance Residuals:
##     Min        1Q    Median        3Q       Max
## -0.48535  -0.48535  -0.00005  -0.00005   2.09629

## Coefficients:
##                Estimate Std. Error z value Pr(>|z|)
## (Intercept)      -20.57    2458.76  -0.008    0.993
## apsq_threshold    18.49    2458.76   0.008    0.994

## (Dispersion parameter for binomial family taken to be 1)

## Null deviance: 39.390  on 96  degrees of freedom
## Residual deviance: 31.395  on 95  degrees of freedom
##   (289 observations deleted due to missingness)
## AIC: 35.395

## Number of Fisher Scoring iterations: 19

## Power for logistic regression

## p0       p1  beta0  beta1  n  alpha     power
## 1.170226e-09 0.1111111 -20.56607 18.48663 97 0.05 0.05000222

## URL: http://psychstat.org/logistic

```

### PHQ9 Q9 Paralympic Athletes

```r
## Call:
glm(formula = depression_9_threshold ~ apsq_threshold, family = binomial, 
data = model.df.paralympics)

## Deviance Residuals:
##     Min        1Q    Median        3Q       Max
## -0.37146  -0.37146  -0.00005  -0.00005   2.32725

## Coefficients:
##                Estimate Std. Error z value Pr(>|z|)
## (Intercept)      -20.57    2458.76  -0.008    0.993
## apsq_threshold    18.49    2458.76   0.008    0.994

```
## (Intercept)      -20.57    2458.76  -0.008    0.993
## apsq_threshold    17.93    2458.76   0.007    0.994
##
## (Dispersion parameter for binomial family taken to be 1)
##
## Null deviance: 26.763  on 96  degrees of freedom
## Residual deviance: 22.044  on 95  degrees of freedom
## (289 observations deleted due to missingness)
## AIC: 26.044
##
## Number of Fisher Scoring iterations: 19

## apsq_threshold
##       61038245

## Power for logistic regression
##
## p0         p1     beta0    beta1  n alpha      power
## 1.170226e-09 0.06666667 -20.56607 17.92701 97  0.05 0.05000209

## URL: http://psychstat.org/logistic

#ASSQ Paralympic Athletes

## Call:
## glm(formula = sleep_threshold ~ apsq_threshold, family = binomial, 
##     data = model.df.paralympics)

## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.7876  -0.7876  -0.4497  -0.4497   2.1642

## Coefficients:
##                Estimate Std. Error z value Pr(>|z|)
## (Intercept)     -2.2407     0.4703  -4.764  1.9e-06 ***
## apsq_threshold   1.2291     0.5787   2.124   0.0337 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

## (Dispersion parameter for binomial family taken to be 1)

## Null deviance: 90.040  on 96  degrees of freedom
## Residual deviance: 85.113  on 95  degrees of freedom
## (289 observations deleted due to missingness)
## AIC: 89.113

## Number of Fisher Scoring iterations: 4

## apsq_threshold
##       3.418182
## Power for logistic regression

```r
# p0 p1 beta0 beta1 n alpha power
# 0.09615385 0.2666667 -2.24071 1.229109 97 0.05 0.5555677
```

## URL: http://psychstat.org/logistic

# Alcohol Paralympic Athletes

```r
# Call:
# glm(formula = alcohol_threshold ~ apsq_threshold, family = binomial,
#     data = model.df.paralympics)
#
# Deviance Residuals:
#     Min       1Q   Median       3Q      Max
# -0.9741  -0.9741  -0.8250   1.3953   1.5768
#
# Coefficients:
#                Estimate Std. Error    z value  Pr(>|z|)
# (Intercept)     -0.9029     0.3061   -2.950   0.00318 **
# apsq_threshold   0.4039     0.4339    0.931   0.35191 
# ---
# Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
#
# (Dispersion parameter for binomial family taken to be 1)
# Null deviance: 123.02  on 96  degrees of freedom
# Residual deviance: 122.15  on 95  degrees of freedom
# (289 observations deleted due to missingness)
# AIC: 126.15
#
# Number of Fisher Scoring iterations: 4
```

```r
# apsq_threshold
# 1.497619
```

## Power for logistic regression

```r
# p0 p1 beta0 beta1 n alpha power
# 0.2884615 0.3777778 -0.9028677 0.4038765 97 0.05 0.1536799
```

## URL: http://psychstat.org/logistic

# Drug Paralympic Athletes

```r
# Call:
# glm(formula = drug_threshold ~ apsq_threshold, family = binomial,
#     data = model.df.paralympics)
```

## Supplemental material

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## Deviance Residuals:
```
          Min     1Q Median     3Q    Max
```

## Coefficients:
```
                Estimate Std. Error z value Pr(>|z|)    
(Intercept)  -2.657e+01  4.939e+04  -0.001        1    
apsq_threshold -1.746e-14  7.251e+04   0.000        1    
```

(Dispersion parameter for binomial family taken to be 1)
```
       Null deviance: 0.0000e+00  on 96  degrees of freedom
Residual deviance: 5.6275e-10  on 95  degrees of freedom
(289 observations deleted due to missingness)
AIC: 4
```

Number of Fisher Scoring iterations: 25

## Power for logistic regression
```
 # p0          p1   beta0     beta1  n alpha power
 2.900701e-12 2.900701e-12 -26.56607 -1.765255e-14 97  0.05  0.05
```

URL: http://psychstat.org/logistic

# Food Paralympic Athletes

## Call:
```
glm(formula = food_threshold ~ apsq_threshold, family = binomial, 
data = model.df.paralympics)
```

## Deviance Residuals:
```
          Min     1Q Median     3Q    Max
-2.4954  -0.6609  -0.6609   0.3015   1.8049
```

## Coefficients:
```
                Estimate Std. Error z value Pr(>|z|)    
(Intercept)  -1.4104     0.1742  -8.097 5.64e-16 ***
apsq_threshold  4.4784     0.7440   6.020 1.75e-09 ***
```

---

Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)
```
       Null deviance: 322.42  on 253  degrees of freedom
Residual deviance: 223.29  on 252  degrees of freedom
(132 observations deleted due to missingness)
## AIC: 227.29

## Number of Fisher Scoring iterations: 5

## apsq_threshold
## 88.09756

## Power for logistic regression
##
## | p0      | p1      | beta0 | beta1 | n   | alpha | power |
## |---------|---------|-------|-------|-----|-------|-------|
## | 0.1961722 | 0.9555556 | -1.410392 | 4.478445 | 254 | 0.05  | 1     |

## URL: http://psychstat.org/logistic

#GAD7 Summer Athletes

## Call:
## glm(formula = anxiety_threshold ~ apsq_threshold, family = binomial,
##     data = model.df.summer)

## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.5042  -0.5042  -0.0927  -0.0927   3.3018

## Coefficients:
##                Estimate Std. Error z value Pr(>|z|)
## (Intercept)     -5.4467     0.7086  -7.686 1.51e-14 ***
## apsq_threshold   3.4481     0.7357   4.687 2.78e-06 ***
## ---
## Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

## (Dispersion parameter for binomial family taken to be 1)

## Null deviance: 254.68  on 708  degrees of freedom
## Residual deviance: 203.48  on 707  degrees of freedom
## (2731 observations deleted due to missingness)
## AIC: 207.48

## Number of Fisher Scoring iterations: 8

## apsq_threshold
## 31.43925

## Power for logistic regression
##
## | p0      | p1      | beta0 | beta1 | n   | alpha | power |
## |---------|---------|-------|-------|-----|-------|-------|
## | 0.004291845 | 0.1193416 | -5.446737 | 3.448057 | 709 | 0.05  | 0.9861055 |

## URL: http://psychstat.org/logistic
#PHQ9 Summer Athletes

## Call:
```
glm(formula = depression_threshold ~ apsq_threshold, family = binomial,
data = model.df.summer)
```

## Deviance Residuals:
```
  Min   1Q Median   3Q   Max
-0.39233 -0.39233 -0.00003 -0.00003 2.28153
```

## Coefficients:
```
##             Estimate Std. Error     z value  Pr(>|z|)
(Intercept)    -21.571    1354.168     -0.016    0.987
apsq_threshold  19.042    1354.168      0.014    0.989
```

# (Dispersion parameter for binomial family taken to be 1)
## Null deviance: 167.78 on 708 degrees of freedom
## Residual deviance: 128.33 on 707 degrees of freedom
## (2731 observations deleted due to missingness)
## AIC: 132.33

## Number of Fisher Scoring iterations: 20

## apsq_threshold
```
  185829445
```

## Power for logistic regression
```
##  p0   p1 beta0 beta1   n alpha   power
## 4.305023e-10 0.07407407 -21.56607 19.04034 709 0.05 0.05000634
```

## URL: http://psychstat.org/logistic

#PHQ9 Q9 Summer Athletes

## Call:
```
glm(formula = depression_9_threshold ~ apsq_threshold, family = binomial,
data = model.df.summer)
```

## Deviance Residuals:
```
  Min   1Q Median   3Q   Max
-0.34445 -0.34445 -0.0655  -0.0655   3.5855
```

## Coefficients:
```
##             Estimate Std. Error     z value  Pr(>|z|)
(Intercept)    -6.14213 1.0008619     -6.138    8.37e-10 ***
apsq_threshold  3.34703 1.0382037     3.22476    0.00126 **
```

---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## (Dispersion parameter for binomial family taken to be 1)
## Null deviance: 145.35 on 708 degrees of freedom
## Residual deviance: 121.38 on 707 degrees of freedom
## (2731 observations deleted due to missingness)
## AIC: 125.38
## Number of Fisher Scoring iterations: 8

## apsq_threshold
##       28.42794

## Power for logistic regression
## p0     p1     beta0    beta1   n alpha     power
## 0.002145923 0.05761317 -6.142037 3.347372 709  0.05 0.8161029

# URL: http://psychstat.org/logistic

#ASSQ Summer Athletes

## Call:
## glm(formula = sleep_threshold ~ apsq_threshold, family = binomial,
## data = model.df.summer)
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.8937  -0.4663  -0.4663  -0.4663   2.1321
## Coefficients:
##                Estimate Std. Error z value Pr(>|z|)
## (Intercept)   -2.1643     0.1524   -14.2  < 2e-16 ***
## apsq_threshold 1.4526     0.2046     7.1 1.25e-12 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## (Dispersion parameter for binomial family taken to be 1)
## Null deviance: 669.59 on 708 degrees of freedom
## Residual deviance: 617.02 on 707 degrees of freedom
## (2731 observations deleted due to missingness)
## AIC: 621.02
## Number of Fisher Scoring iterations: 4

## apsq_threshold
##       4.274029
## Power for logistic regression

##

###
<table>
<thead>
<tr>
<th>p0</th>
<th>p1</th>
<th>beta0</th>
<th>beta1</th>
<th>n</th>
<th>alpha</th>
<th>power</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1030043</td>
<td>0.3292181</td>
<td>-2.16428</td>
<td>1.452557</td>
<td>709</td>
<td>0.05</td>
<td>0.9999997</td>
</tr>
</tbody>
</table>

## URL: http://psychstat.org/logistic

# Alcohol Summer Athletes

## Call:

```r
# glm(formula = alcohol_threshold ~ apsq_threshold, family = binomial,  
# data = model.df.summer)
```

## Deviance Residuals:

<table>
<thead>
<tr>
<th>Min</th>
<th>1Q</th>
<th>Median</th>
<th>3Q</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1.003</td>
<td>-0.730</td>
<td>-0.730</td>
<td>1.363</td>
<td>1.705</td>
</tr>
</tbody>
</table>

## Coefficients:

| Estimate | Std. Error | z value | Pr(>|z|) |
|----------|------------|---------|---------|
| (Intercept) | -1.1864 | 0.1094 | -10.84 | < 2e-16 *** |
| apsq_threshold | 0.7603 | 0.1709 | 4.45 | 8.6e-06 *** |

---

## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

## (Dispersion parameter for binomial family taken to be 1)

## Null deviance: 852.76  on 708  degrees of freedom
## Residual deviance: 833.05  on 707  degrees of freedom
## (2731 observations deleted due to missingness)
## AIC: 837.05

## Number of Fisher Scoring iterations: 4

## apsq_threshold

## 2.138925

## Power for logistic regression

<table>
<thead>
<tr>
<th>p0</th>
<th>p1</th>
<th>beta0</th>
<th>beta1</th>
<th>n</th>
<th>alpha</th>
<th>power</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2339056</td>
<td>0.3950617</td>
<td>-1.186388</td>
<td>0.7603035</td>
<td>709</td>
<td>0.05</td>
<td>0.9956171</td>
</tr>
</tbody>
</table>

## URL: http://psychstat.org/logistic

# Drug Summer Athletes

## Call:

```r
# glm(formula = drug_threshold ~ apsq_threshold, family = binomial,  
# data = model.df.summer)
```

## Apologies

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Supplemental material placed on this supplemental material which has been supplied by the author(s)
## Deviance Residuals:
##     Min  1Q Median  3Q Max
## -0.1286 -0.1286 -0.1137 -0.1137 3.1767
##
## Coefficients:
##                Estimate Std. Error z value Pr(>|z|)
## (Intercept)     -5.0391     0.5791  -8.702   <2e-16 ***
## apsq_threshold  0.2475     0.9162   0.270    0.787
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 59.509  on 708  degrees of freedom
## Residual deviance: 59.437  on 707  degrees of freedom
##   (2731 observations deleted due to missingness)
## AIC: 63.437
##
## Number of Fisher Scoring iterations: 7
##
## apsq_threshold
##     1.280774
##
## Power for logistic regression
##
##              p0          p1     beta0     beta1   n alpha      power
##     0.006437769 0.008230453 -5.039115 0.2474649 709  0.05 0.05896549
##
## URL: http://psychstat.org/logistic

# Food Summer Athletes

## Call:
## glm(formula = food_threshold ~ apsq_threshold, family = binomial,
##     data = model.df.summer)
##
## Deviance Residuals:
##     Min  1Q Median  3Q Max
## -2.2349 -0.8878 -0.8878 1.4978 1.4978
##
## Coefficients:
##                Estimate Std. Error z value Pr(>|z|)
## (Intercept)    -0.72759    0.06323  -11.51   <2e-16 ***
## apsq_threshold  3.13903    0.24183   12.98   <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##     Null deviance: 1888.5  on 1381  degrees of freedom
##
## Residual deviance: 1575.9 on 1380 degrees of freedom
##  (2058 observations deleted due to missingness)
## AIC: 1579.9
##
## Number of Fisher Scoring iterations: 5
##
## apsq_threshold
##  23.0814
##
## Power for logistic regression
##
##    p0        p1    beta0    beta1    n  alpha  power
##  0.3257243 0.9176955 -0.7275877 3.139027 1382 0.05  1
##
## URL: http://psychstat.org/logistic

#GAD7 Winter Athletes

## Call:
## glm(formula = anxiety_threshold ~ apsq_threshold, family = binomial,
##     data = model.df.winter)
##
## Deviance Residuals:
##      Min        1Q    Median        3Q       Max
## -0.52066  -0.00003  -0.00003  -0.00003   2.03246
##
## Coefficients:
##                     Estimate Std. Error z value Pr(>|z|)
## (Intercept)      -21.57    1728.55  -0.012    0.990
## apsq_threshold    19.64    1728.55   0.011    0.991
##
## (Dispersion parameter for binomial family taken to be 1)
##
## Null deviance: 84.020  on 356 degrees of freedom
## Residual deviance: 53.986  on 355 degrees of freedom
##   (345 observations deleted due to missingness)
## AIC: 57.986
##
## Number of Fisher Scoring iterations: 20
##
## apsq_threshold
##      337190535
##
## Power for logistic regression
##
##       p0        p1    beta0    beta1    n  alpha  power
## 4.305023e-10 0.1267606 -21.56607 19.63616 357 0.05 0.05000339
##
## URL: http://psychstat.org/logistic
#PHQ9 Winter Athletes

## Call:
```r
glm(formula = depression_threshold ~ apsq_threshold, family = binomial, 
data = model.df.winter)
```

## Deviance Residuals:
```r
       Min       1Q   Median       3Q      Max
-0.2391 -0.0837 -0.0837 -0.0837   3.3633
```

## Coefficients:
```r
                Estimate Std. Error z value Pr(>|z|)
(Intercept)      -5.652      1.002  -5.643 1.67e-08 *** 
apsq_threshold    2.112      1.232   1.714   0.0866 .
```

---

## Null deviance: 34.649 on 356 degrees of freedom
## Residual deviance: 31.530 on 355 degrees of freedom
## (345 observations deleted due to missingness)
## AIC: 35.53

## Number of Fisher Scoring iterations: 8

## apsq_threshold
```r
8.26087
```

## Power for logistic regression
```r
   p0   p1 beta0 beta1   n alpha  power
0.00349503 0.02816901 -5.652489 2.11153 357  0.05 0.3479
```

## URL: http://psychstat.org/logistic

#PHQ9 Q9 Winter Athletes

## Warning: glm.fit: algorithm did not converge

## Call:
```r
glm(formula = depression_9_threshold ~ apsq_threshold, family = binomial, 
data = model.df.winter)
```

## Deviance Residuals:
```r
       Min       1Q   Median       3Q      Max
```

## Coefficients:
## Estimate Std. Error z value Pr(>|z|)
## (Intercept)   -2.657e+01  2.106e+04  -0.001    0.999
## apsq_threshold -1.190e-14  4.722e+04   0.000    1.000
##
## (Dispersion parameter for binomial family taken to be 1)
##
## Null deviance: 0.0000e+00  on 356 degrees of freedom
## Residual deviance: 2.0712e-09  on 355 degrees of freedom
## (345 observations deleted due to missingness)
## AIC: 4
##
## Number of Fisher Scoring iterations: 25
##
## Number of Fisher Scoring iterations: 25

## Power for logistic regression
##
## p0   p1 beta0 beta1 n alpha power
## 2.900701e-12 2.900701e-12 -26.56607 -1.076916e-14 357  0.05  0.05

## URL: http://psychstat.org/logistic

#ASSQ Winter Athletes

## Call:
## glm(formula = sleep_threshold ~ apsq_threshold, family = binomial,
##     data = model.df.winter)
##
## Deviance Residuals:
##     Min       1Q   Median       3Q      Max
## -0.9317  -0.3708  -0.3708  -0.3708   2.3288
##
## Coefficients:
## Estimate Std. Error z value Pr(>|z|)
## (Intercept)   -2.6428     0.2374 -11.131  < 2e-16 ***
## apsq_threshold  2.0330     0.3437   5.916 3.31e-09 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
## Null deviance: 266.57  on 356 degrees of freedom
## Residual deviance: 231.87  on 355 degrees of freedom
## (345 observations deleted due to missingness)
## AIC: 235.87
##
## Number of Fisher Scoring iterations: 5
## apsq_threshold

##         7.6373

## Power for logistic regression

##             p0        p1    beta0    beta1   n alpha     power
##     0.06643357 0.3521127 -2.64281 2.033044 357  0.05 0.9999731

## URL: http://psychstat.org/logistic

# Alcohol Winter Athletes

## Call:
## glm(formula = alcohol_threshold ~ apsq_threshold, family = binomial,
##     data = model.df.winter)

## Deviance Residuals:
##    Min      1Q  Median      3Q     Max
## -1.391  -0.916  -0.916   1.464   1.464

## Coefficients:
##                Estimate Std. Error z value Pr(>|z|)
## (Intercept)     -0.6515     0.1246  -5.229 1.71e-07 ***
## apsq_threshold   1.1398     0.2744   4.154 3.27e-05 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

## (Dispersion parameter for binomial family taken to be 1)

## Null deviance: 479.87  on 356  degrees of freedom
## Residual deviance: 461.99  on 355  degrees of freedom
##   (345 observations deleted due to missingness)
## AIC: 465.99

## Number of Fisher Scoring iterations: 4

## apsq_threshold
##        3.126228

## Power for logistic regression

##             p0        p1    beta0    beta1   n alpha     power
##     0.3426573 0.6197183 -0.6514745 1.139827 357  0.05 0.9993319

## URL: http://psychstat.org/logistic

# Drug Winter Athletes

## Call:
### glm(formula = drug_threshold ~ apsq_threshold, family = binomial, data = model.df.winter)

### Deviance Residuals:

<table>
<thead>
<tr>
<th>Min</th>
<th>1Q</th>
<th>Median</th>
<th>3Q</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.3406</td>
<td>-0.1185</td>
<td>-0.1185</td>
<td>-0.1185</td>
<td>3.1505</td>
</tr>
</tbody>
</table>

### Coefficients:

|                | Estimate | Std. Error | z value | Pr(>|z|) |
|----------------|----------|------------|---------|----------|
| (Intercept)    | -4.9558  | 0.7095     | -6.985  | 2.85e-12 *** |
| apsq_threshold | 2.1374   | 0.8765     | 2.438   | 0.0147 * |

---

### Signif. codes:  
0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

Null deviance: 60.930 on 356 degrees of freedom
Residual deviance: 54.619 on 355 degrees of freedom

(345 observations deleted due to missingness)
AIC: 58.619

Number of Fisher Scoring iterations: 7

### Power for logistic regression

<table>
<thead>
<tr>
<th>p0</th>
<th>p1</th>
<th>beta0</th>
<th>beta1</th>
<th>n</th>
<th>alpha</th>
<th>power</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.006993007</td>
<td>0.05633803</td>
<td>-4.955827</td>
<td>2.137429</td>
<td>357</td>
<td>0.05</td>
<td>0.6095234</td>
</tr>
</tbody>
</table>

URL: http://psychstat.org/logistic

---

### Food Winter Athletes

### Call:

```
# glm(formula = food_threshold ~ apsq_threshold, family = binomial, data = model.df.winter)
```

### Deviance Residuals:

<table>
<thead>
<tr>
<th>Min</th>
<th>1Q</th>
<th>Median</th>
<th>3Q</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2.5156</td>
<td>-1.5155</td>
<td>0.8735</td>
<td>0.8735</td>
<td>0.8735</td>
</tr>
</tbody>
</table>

### Coefficients:

|                | Estimate | Std. Error | z value | Pr(>|z|) |
|----------------|----------|------------|---------|----------|
| (Intercept)    | 0.7669   | 0.1222     | 6.273   | 3.53e-10 *** |
| apsq_threshold | 2.3540   | 0.6024     | 3.908   | 9.31e-05 *** |

---

### Signif. codes:  
0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
(Dispersion parameter for binomial family taken to be 1)

Null deviance: 440.06 on 379 degrees of freedom
Residual deviance: 410.92 on 378 degrees of freedom
(322 observations deleted due to missingness)
AIC: 414.92

Number of Fisher Scoring iterations: 5

Power for logistic regression

---

Power for multiple regression

#GAD7 by sex
## Call:
# lm(formula = GAD_total ~ Gender, data = model.df)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -3.628 -2.168 -2.168  1.831 18.831
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   3.6276     0.1636  22.168  < 2e-16 ***
## GenderMale   -1.4591     0.2381  -6.129  1.2e-09 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4.085 on 1179 degrees of freedom
## (2961 observations deleted due to missingness)
## Multiple R-squared:  0.03088,    Adjusted R-squared:  0.03006
## F-statistic: 37.57 on 1 and 1179 DF,  p-value: 1.204e-09
##
## Power for multiple regression
##
##       n p1 p2         f2 alpha     power
##     1181  1  0 0.03186197  0.05 0.9999847
##
## URL: http://psychstat.org/regression

#PHQ9 by sex

## Call:
# lm(formula = PHQ_total ~ Gender, data = model.df)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -2.6342 -1.6342 -1.6188  0.3812 20.3812
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   2.6342     0.1414  18.631  < 2e-16 ***
## GenderMale   -1.0154     0.2038  -4.983 7.25e-07 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 3.42 on 1126 degrees of freedom
## (3014 observations deleted due to missingness)
## Multiple R-squared:  0.02157,    Adjusted R-squared:  0.02071
## F-statistic: 24.83 on 1 and 1126 DF,  p-value: 7.249e-07
##
## Power for multiple regression
##
##       n p1 p2         f2 alpha     power
##     1181  1  0 0.03186197  0.05 0.9999847
##
## URL: http://psychstat.org/regression
## Power for multiple regression

```r
## n p1 p2 f2 alpha power
## 1128 1 0 0.001860472 0.05 0.3044642
## URL: http://psychstat.org/regression
```

---

### ASSQ by sex

```r
## Call:
## lm(formula = ASSQ_total ~ Gender, data = model.df)
## Residuals:
## Min 1Q Median 3Q Max
## -5.0529 -2.0529 -0.7857 1.2143 10.9471
## Coefficients:
## Estimate Std. Error t value Pr(>|t|)
## (Intercept) 5.0529 0.1190 42.472 <2e-16 ***
## GenderMale -0.2672 0.1707 -1.566 0.118
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

---

```
## Call:
## lm(formula = PHQ_Full_7_numeric ~ Gender, data = model.df)
## Residuals:
## Min 1Q Median 3Q Max
## -0.03590 -0.03590 -0.03590 -0.02026 1.96410
## Coefficients:
## Estimate Std. Error t value Pr(>|t|)
## (Intercept) 0.035897 0.007497 4.788 1.91e-06 ***
## GenderMale -0.015640 0.010806 -1.447 0.148
## ---
## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
## Residual standard error: 0.1813 on 1126 degrees of freedom
## (3014 observations deleted due to missingness)
## Multiple R-squared: 0.001857, Adjusted R-squared: 0.0009706
## F-statistic: 2.095 on 1 and 1126 DF, p-value: 0.1481
```

```r
## n p1 p2 f2 alpha power
## 1128 1 0 0.001860472 0.05 0.3044642
## URL: http://psychstat.org/regression
```
## Residual standard error: 2.785 on 1064 degrees of freedom
## (3076 observations deleted due to missingness)
## Multiple R-squared:  0.002299,  Adjusted R-squared:  0.001361
## F-statistic: 2.451 on 1 and 1064 DF,  p-value: 0.1177

## Power for multiple regression
##
##        n p1 p2          f2 alpha     power
##     1066  1  0 0.002303821  0.05 0.3469072
##
## URL: http://psychstat.org/regression

# Alcohol by sex

## Call:
## lm(formula = Alcohol_total ~ Gender, data = model.df)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -2.6178 -1.1569 -0.1569  0.8431  8.3822
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  2.15693    0.07195  29.976  < 2e-16 ***
## GenderMale   0.46083    0.10322   4.464 8.88e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.684 on 1064 degrees of freedom
## (3076 observations deleted due to missingness)
## Multiple R-squared:  0.01839,    Adjusted R-squared:  0.01747
## F-statistic: 19.93 on 1 and 1064 DF,  p-value: 8.884e-06

## Power for multiple regression
##
##        n p1 p2         f2 alpha     power
##     1066  1  0 0.01873227  0.05 0.9938709
##
## URL: http://psychstat.org/regression

# Drug by sex

## Call:
## lm(formula = Drug_total ~ Gender, data = model.df)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -0.0676 -0.0676 -0.0365 -0.0365  3.9635
##
## Coefficients:
```
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)  0.03650    0.01434  2.545   0.0111 *
## GenderMale   0.03107    0.02057   1.510   0.1312
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.3357 on 1064 degrees of freedom
## (3076 observations deleted due to missingness)
## Multiple R-squared:  0.002139,   Adjusted R-squared:  0.001202
## F-statistic: 2.281 on 1 and 1064 DF,  p-value: 0.1312
##
## Power for multiple regression
##```
```
##        n p1 p2          f2 alpha     power
##     1066  1  0 0.002144034  0.05 0.3267852
##
## URL: http://psychstat.org/regression
```
## lm(formula = SMHAT_total ~ games, data = model.df)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -3.449 -2.952 -1.952  1.924 21.551
##
## Coefficients:
##                Estimate Std. Error t value Pr(>|t|)
## (Intercept)    12.9516     0.1107 117.037   <2e-16 ***
## gamesparalympics  0.4972     0.2915   1.706   0.0882 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4.297 on 1760 degrees of freedom
## (2380 observations deleted due to missingness)
## Multiple R-squared:  0.001651,   Adjusted R-squared:  0.001084
## F-statistic:  2.91 on 1 and 1760 DF,  p-value: 0.08819
##
## Power for multiple regression
##
##        n p1 p2         f2 alpha     power
##     1762  1  0 0.00165358  0.05 0.3998841
##
## URL: http://psychstat.org/regression
#
#GAD7 by games
#
## Call:
## lm(formula = GAD_total ~ games, data = model.df)
##
## Residuals:
##    Min     1Q Median     3Q    Max
##  -3.57  -2.88  -1.88  2.12  18.12
##
## Coefficients:
##                Estimate Std. Error t value Pr(>|t|)
## (Intercept)    2.8797     0.1261  22.844   <2e-16 ***
## gamesparalympics  0.6903     0.4332   1.593    0.111
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4.145 on 1179 degrees of freedom
## (2961 observations deleted due to missingness)
## Multiple R-squared:  0.002149,   Adjusted R-squared:  0.001302
## F-statistic: 2.539 on 1 and 1179 DF,  p-value: 0.1113
##
## Power for multiple regression
##
##        n p1 p2          f2 alpha     power
##     1181  1  0 0.00165358  0.05 0.3571662
## Multiple R-squared: 1.095e-05, Adjusted R-squared: -0.0008771
## F-statistic: 0.01233 on 1 and 1126 DF, p-value: 0.9116
## Power for multiple regression
##
##        n  p1 p2           f2    alpha      power
##     1128  1  0 1.094637e-05  0.05 0.05141321
##
## URL: http://psychstat.org/regression

# ASSQ by games

## Call:
## lm(formula = ASSQ_total ~ games, data = model.df)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -5.443 -1.871 -0.871  1.129 11.129
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)       4.87100    0.08941  54.477   <2e-16 ***
## gamesparalympics  0.57230    0.29641   1.931   0.0538 .
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 2.783 on 1064 degrees of freedom
## (3076 observations deleted due to missingness)
## Multiple R-squared:  0.003491, Adjusted R-squared:  0.002555
## F-statistic: 3.728 on 1 and 1064 DF, p-value: 0.05378
## Power for multiple regression
##
## URL: http://psychstat.org/regression

# Alcohol by games

## Call:
## lm(formula = Alcohol_total ~ games, data = model.df)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -2.3488 -1.3488 -0.3488  0.6512  8.6512
##
## Coefficients:
##                  Estimate Std. Error t value Pr(>|t|)
## (Intercept)       4.87100    0.08941  54.477   <2e-16 ***
## gamesparalympics  0.57230    0.29641   1.931   0.0538 .

# Drug by games

## Call:
```r
lm(formula = Drug_total ~ games, data = model.df)
```

## Residuals:
```
Min  1Q Median  3Q Max
-0.0526 -0.0526 -0.0526 -0.0526 3.9474
```

## Coefficients:
```
                         Estimate Std. Error t value Pr(>|t|)
(Intercept)              0.05263    0.01080   4.875 1.25e-06 ***
gamesparalympics  -0.01139    0.03579  -0.318     0.75
```

## Residual standard error: 0.336 on 1064 degrees of freedom
## (3076 observations deleted due to missingness)
## Multiple R-squared:  9.527e-05, Adjusted R-squared:  -0.0008445
## F-statistic: 0.1014 on 1 and 1064 DF,  p-value: 0.7502

## Power for multiple regression
```
 n p1 p2 f2 alpha power
1066 1 0 9.527949e-05 0.05 0.06169336
```

## URL: http://psychstat.org/regression

# Food by games

## Call:
```r
lm(formula = Food_total ~ games, data = model.df)
```
## Residuals:
##    Min     1Q Median     3Q    Max
##
## Coefficients:
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)       2.49947    0.08693  28.753   <2e-16 ***
## gamesparalympics  0.13784    0.28476   0.484    0.628
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 5.328 on 4140 degrees of freedom
## Multiple R-squared:  5.659e-05,  Adjusted R-squared:  -0.0001849
## F-statistic: 0.2343 on 1 and 4140 DF,  p-value: 0.6284
##
## Power for multiple regression
##
## | n | p1 | p2 | f2  | alpha | power |
## |---|----|----|-----|-------|-------|
## | 4142 | 1  | 0 | 5.659442e-05 | 0.05   | 0.07724604 |
##
## URL: http://psychstat.org/regression

#SMHAT_total by season

##
## Call:
## lm(formula = SMHAT_total ~ season, data = model.df)
##
## Residuals:
##    Min     1Q Median     3Q    Max
## -3.205 -2.973 -1.973  1.795 22.027
##
## Coefficients:
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)       12.9732     0.1157 112.163   <2e-16 ***
## seasonwinter     0.2320     0.2491   0.932    0.352
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4.3 on 1760 degrees of freedom
## (2380 observations deleted due to missingness)
## Multiple R-squared:  0.0004929,  Adjusted R-squared:  -7.5e-05
## F-statistic: 0.8679 on 1 and 1760 DF,  p-value: 0.3517
##
## Power for multiple regression
##
## | n | p1 | p2 | f2  | alpha | power |
## |---|----|----|-----|-------|-------|
## | 1762 | 1  | 0 | 0.0004934297 | 0.05   | 0.1538187 |
##
## URL: http://psychstat.org/regression
#GAD7 by season

## Call:
`lm(formula = GAD_total ~ season, data = model.df)`

## Residuals:
Min 1Q Median 3Q Max
-3.359 -3.359 -2.005 1.641 17.641

## Coefficients:

| Estimate | Std. Error | t value | Pr(>|t|) |
|----------|------------|---------|----------|
| (Intercept) | 3.3587 | 0.1438 | 23.364 < 2e-16 *** |
| seasonwinter | -1.3533 | 0.2579 | -5.248 1.83e-07 *** |

## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

## Residual standard error: 4.101 on 1179 degrees of freedom
## (2961 observations deleted due to missingness)
## Multiple R-squared: 0.02282, Adjusted R-squared: 0.022
## F-statistic: 27.54 on 1 and 1179 DF, p-value: 1.825e-07

## Power for multiple regression

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</table>

## URL: http://psychstat.org/regression

#PHQ9 by season

## Call:
`lm(formula = PHQ_total ~ season, data = model.df)`

## Residuals:
Min 1Q Median 3Q Max
-2.5392 -2.5392 -1.3122 0.6878 20.4608

## Coefficients:

| Estimate | Std. Error | t value | Pr(>|t|) |
|----------|------------|---------|----------|
| (Intercept) | 2.5392 | 0.1232 | 20.613 < 2e-16 *** |
| seasonwinter | -1.2270 | 0.2174 | -5.643 2.12e-08 *** |

## Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

## Residual standard error: 3.409 on 1126 degrees of freedom
## (3014 observations deleted due to missingness)
## Multiple R-squared: 0.0275, Adjusted R-squared: 0.022
## F-statistic: 31.84 on 1 and 1126 DF, p-value: 2.116e-08
## Power for multiple regression
##
##        n p1 p2         f2 alpha     power
##     1128  1  0 0.02827804  0.05 0.9998848
##
## URL: http://psychstat.org/regression

#PHQ9 Q9 by season
#
## Call:
## lm(formula = PHQ_Full_7_numeric ~ season, data = model.df)
##
## Residuals:
##    Min      1Q  Median      3Q     Max
## -0.04178 -0.04178 -0.04178  0.00000  1.95822
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   0.04177    0.00652   6.408 2.17e-10 ***
## seasonwinter -0.04177    0.01151  -3.630 0.000296 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.1804 on 1126 degrees of freedom
##   (3014 observations deleted due to missingness)
## Multiple R-squared:  0.01157,    Adjusted R-squared:  0.01069
## F-statistic: 13.18 on 1 and 1126 DF,  p-value: 0.0002963
##
## Power for multiple regression
##
##        n p1 p2         f2 alpha     power
##     1128  1  0 0.01170147  0.05 0.9525417
##
## URL: http://psychstat.org/regression

#ASSQ by season
#
## Call:
## lm(formula = ASSQ_total ~ season, data = model.df)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -5.0818 -2.0818 -0.6078  1.3922 10.9182
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)    5.0818     0.1044  48.688  < 2e-16 ***
## seasonwinter  -0.4740     0.1804  -2.628  0.00872 **
## ---
##
# Alcohol by season

## Call:
```
lm(formula = Alcohol_total ~ season, data = model.df)
```

## Residuals:
```
     Min      1Q  Median      3Q     Max
-2.8319 -1.1537 -0.1537  0.8463  8.8463
```

## Coefficients:
```
              Estimate Std. Error t value Pr(>|t|)
(Intercept)   2.15374    0.06271  34.347  < 2e-16 ***
seasonwinter  0.67820    0.10835   6.259 5.61e-10 ***
```

## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

## Residual standard error: 1.67 on 1064 degrees of freedom
## (3076 observations deleted due to missingness)

## Multiple R-squared:  0.03551,    Adjusted R-squared:  0.03461

## F-statistic: 39.18 on 1 and 1064 DF,  p-value: 5.608e-10

## Power for multiple regression
```
##        n p1 p2         f2 alpha     power
##     1066  1  0 0.03681902  0.05 0.9999914
```

## URL: http://psychstat.org/regression

# Drug by season

## Call:
```
lm(formula = Drug_total ~ season, data = model.df)
```

## Residuals:
```
     Min      1Q  Median      3Q     Max
```

## Coefficients:
```
```

## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

## Residual standard error: 1.67 on 1064 degrees of freedom
## (3076 observations deleted due to missingness)

## Multiple R-squared:  0.03551,    Adjusted R-squared:  0.03461

## F-statistic: 39.18 on 1 and 1064 DF,  p-value: 5.608e-10

## Power for multiple regression
```
##        n p1 p2         f2 alpha     power
##     1066  1  0 0.03681902  0.05 0.9999914
```

## URL: http://psychstat.org/regression
## Coefficients:

|                      | Estimate | Std. Error | t value | Pr(>|t|) |
|----------------------|----------|------------|---------|----------|
| (Intercept)          | 0.04513  | 0.01262    | 3.577   | 0.000363 *** |
| seasonwinter         | 0.01929  | 0.02180    | 0.885   | 0.376407 |

---

Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.3359 on 1064 degrees of freedom

(3076 observations deleted due to missingness)

Multiple R-squared: 0.0007354, Adjusted R-squared: -0.0002037

F-statistic: 0.7831 on 1 and 1064 DF,  p-value: 0.3764

---

Power for multiple regression

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<th>f2</th>
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</table>

URL: http://psychstat.org/regression

# Food by season

---

Call:

```
lm(formula = Food_total ~ season, data = model.df)
```

Residuals:

```
Min     1Q Median     3Q    Max
-4.370 -2.133 -2.133 -2.133 28.867
```

Coefficients:

|                      | Estimate | Std. Error | t value | Pr(>|t|) |
|----------------------|----------|------------|---------|----------|
| (Intercept)          | 2.1331   | 0.0897     | 23.78   | <2e-16 *** |
| seasonwinter         | 2.2372   | 0.2179     | 10.27   | <2e-16 *** |

---

Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 5.261 on 4140 degrees of freedom

Multiple R-squared: 0.02483, Adjusted R-squared: 0.0246

F-statistic: 105.4 on 1 and 4140 DF,  p-value: < 2.2e-16

---

Power for multiple regression

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URL: http://psychstat.org/regression