
The Mental Health Quotient: An Online Tool for Population Assessment of Mental Well-being

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ABSTRACT

Background:

The clinical heritage of mental health assessment means that most tools are built around specific psychiatric disorder classification systems. However, given that the general population falls along a continuum of disordered to thriving, a system that is skewed towards disorders and dysfunction and underrepresents well-being and abilities is not appropriate for the assessment of mental health across the general population. Furthermore, existing mental health assessment tools provide an incomplete picture of symptomatic experience creating ambiguity, bias, and inconsistency in mental health outcomes and confusing the development of effective interventions and policies.

Objective:

The objective of this paper is to present a new online assessment tool designed for the general population called the Mental Health Quotient (MHQ) that covers the complete breadth of mental health and well-being, spanning from normal function to clinical symptoms. Its purpose is to provide a topline assessment of population mental health that is not tied to an arbitrary system of disorder classification, as well as to provide a disorder agnostic view of an individual's mental health profile.

Methods:

The MHQ was developed based on a comprehensive review of 126 existing mental health assessment tools, covering 10,154 questions in total. Coding, consolidation and reorganization of this content resulted in the identification of 47 attributes of mental health and well-being which were formulated into an online tool, accompanied by questions relating to demographic, experiential and momentary factors. Initial data was then collected online from 1017 adult respondents (63% female; aged 18 to 85+) to test the tool. Overall MHQ scores (spanning from -100 to +200), as well as for 6 categories of mental well-being (spanning from -50 to +100) were computed using an algorithm based on a nonlinear weighting of attribute severity, and data was inspected to provide a preliminary illustration of the output.

Results:

The MHQ tool was easy to understand (99.5% agreement) and fast to complete (average 14 minutes). Overall the range of MHQ scores spanned from clinical/at risk (2%/12% of respondents respectively) through to thriving (10%). Preliminary data indicated that MHQ scores were normally distributed in the positive range with an average score of approximately 100 for the overall MHQ and ranged from 48 to 55 for sub-scores in each of 6 mental well-being categories. Scores were lowest in the 18-24 age bracket (24% of scores below 0 indicating clinical/at risk compared to 8% to 14% for all other age brackets). The lowest MHQ scores were seen in the mental well-being categories of Social Self and Mood and Outlook.

Conclusions:

The MHQ provides a quick, easy and comprehensive way to assess mental health and well-being in the general population and identify at-risk groups.

Keywords:

psychiatric; population; personalized; clinical; mental health; well-being; wellness; patient; assessment; diagnosis; method; screening; mHealth; digital health; ehealth.

1. INTRODUCTION

According to the World Health Organization (WHO), mental health is “a state of well-being in which the individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community” [1]. According to this definition, any framework of mental health assessment should therefore reflect not just the absence of ill-health, but also the presence of good health and well-being, ensuring it is applicable not only for clinical groups, but also for the wider population [2]. In addition, while personalized approaches to mental health are essential in ensuring effective treatment outcomes at the level of the individual [3-5], population level approaches provide an understanding of the broader geographical, cultural and experiential factors which influence mental health and well-being on a macro-scale [6,7]. This latter perspective provides an opportunity to develop interventions that induce large-scale shifts in population well-being and is becoming increasingly important to understanding how to improve mental health outcomes [8,9]. However, current approaches to mental health assessment pose considerable challenges to these goals and ideals.

One major challenge is that the clinical heritage of mental health assessment means that the majority of tools are not designed for the general population but instead built around specific psychiatric disorder categories based on the clinical classification systems of the Diagnostic and Statistical Manual of Mental Disorders (DSM) [10] or the International Classification of Diseases (ICD) [11]. In this way an assessment can identify whether an individual exhibits symptoms pertaining to a specific mental health disorder such as depression, attention-deficit/hyperactivity disorder (ADHD) or alcohol addiction but does not readily provide a perspective of their overall mental health and well-being. In contrast, the general population falls along a continuum ranging from disordered to thriving, and therefore having a system that is skewed towards disorders and dysfunction and that underrepresents well-being and abilities is not appropriate. Furthermore, this one-sided perspective to mental health presents a challenge to advancing the discussion of the borders between “normal” mental health and clinical disorder [12-15] especially as many mental health “symptoms” such as sadness, anxiety and risk-taking also fall within the spectrum of

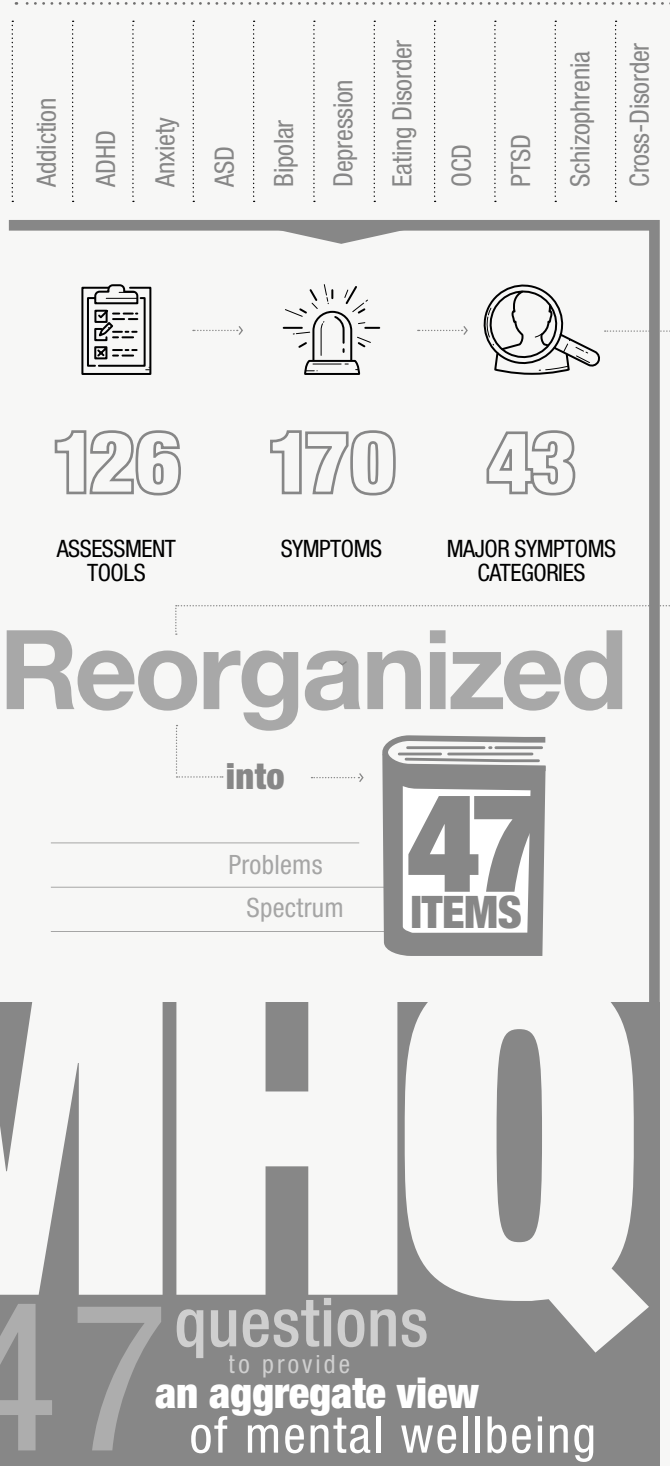
normal mental functioning in the general population. To understand when such normal mental functions cross the boundary to symptoms requires an assessment approach that is designed for the general population and that encompasses the range from dysfunction to positive mental assets.

A second challenge is that existing mental health assessment tools, despite being broadly based on symptom criteria defined by DSM or ICD classification systems, are highly heterogeneous. A recent analysis of commonly used mental health screening assessments revealed considerable inconsistency in symptom assessment across different tools focusing on the same disorder, and substantial overlap between disorders [16]. Consequently, two assessments that target the same population group, but which used different tools to assess their experience of mental health problems, may deliver different results because they are assessing a different set of symptoms (see also [17]). This creates ambiguity, bias and inconsistency in mental health determination and confuses the development of effective interventions to relieve suffering and promote well-being within the general population. Moreover, when examining assessment tools that span multiple disorders and therefore aim to provide a broader perspective to mental health, Newson et al, [16] found that none of the 16 assessment tools analyzed covered the complete breadth of mental health symptoms (see also [18]) and few considered positive mental assets. This suggests that existing cross-disorder tools fail to provide a complete picture of mental health and well-being that would be applicable to a diverse global population.

To address these challenges, we have developed a new online assessment tool called the Mental Health Quotient (MHQ) [19], that is designed for the general population and covers the complete breadth of mental health and well-being, spanning from normal function to clinical symptoms. It has been developed based on an extensive review of the way mental health is assessed in clinical and research fields [16] and its purpose is to provide a topline assessment of population mental health and well-being that is not tied to an arbitrary system of disorder classification, as well as to provide a disorder agnostic view of an individual’s mental health profile. Here we describe the development of the MHQ and provide preliminary data from a cross section of the population to illustrate its output.

2. METHODS

Figure 1: DIAGRAM ILLUSTRATING THE METHOD OF DEVELOPMENT OF THE MHQ



► 126 commonly used psychiatric assessment tools covering 10 disorders (as well as those taking a cross-disorder approach) were reviewed, resulting in the identification of 170 symptoms. These were initially consolidated into 43 symptom categories and then reorganized into a final set of 47 items which were divided into spectrum and problem items for inclusion in the MHQ. Abbreviations: ADHD: Attention Deficit Hyperactivity Disorder; ASD: Autism Spectrum Disorder; OCD: Obsessive Compulsive Disorder; PTSD: Post Traumatic Stress Disorder.

2.1. Design and development of the MHQ

2.1.1. KEY DESIGN CRITERIA

The key design criteria of the MHQ were that it had to be fast and easy to complete by the general population (take 15 minutes or less), administered such that respondents felt confident to provide honest responses, and reflective of the current perception of the respondent's mental health and well-being. The MHQ therefore was designed to provide a view of respondent perception within their individual life context rather than an absolute measure of symptoms. This is in line with the manner in which the majority of mental health symptoms are typically assessed. In addition, as an output it would have to provide an overall score of mental health and well-being as well as scores along key macro dimensions. Taking these requirements into consideration, the MHQ was developed to be taken online anonymously and provide a score and full individual report that encourages honest self-report.

2.1.2. DEVELOPING A COMPLETE INVENTORY OF MENTAL HEALTH AND WELL-BEING ELEMENTS

The MHQ was developed based on a comprehensive review of 126 commonly used psychiatric assessment tools (see Figure 1). Both disorder specific (covering depression, anxiety, bipolar disorder, ADHD, post-traumatic stress disorder, obsessive-compulsive disorder, addiction, schizophrenia, eating disorder and autism spectrum disorder) and cross disorder tools were reviewed (see [16] for a complete list of assessment tools).

The selection of items to include in the MHQ, was performed as follows: The symptoms assessed in 10,154 questions taken from the 126 assessment tools were identified and coded based on a judgement of the semantic content of the question.

These preliminary codings were reviewed and consolidated into a set of symptom categories by grouping together similar preliminary symptom codings (see [16] for further details). This set of symptom categories was then reviewed to assess their appropriateness in the context of an online population assessment of mental health and well-being. This was done in several ways. Firstly, we reviewed the Research Domain Criteria (RDoC) constructs and subconstructs put forward by the National Institute of Mental Health (NIMH) [20-22] to ensure that the list of items reflected the components within this non-DSM framework. Secondly, we made sure there were items within the MHQ which reflected symptoms of neurological disorders (e.g. dementia) which weren't covered in the original review [16]. Thirdly, categories which reflected purely physical symptoms (e.g. urination problems), were not included as individual questions but instead were incorporated under the generalized item of "physical health concerns". Fourthly, where a category reflected multiple symptoms or functions, we split the category into two (or three) independent items to make it clear to the respondent which function/symptom we were assessing (e.g. sleep quality versus nightmares). Finally, we consolidated some categories together where they reflected items that a naive respondent might find difficult to differentiate (e.g. delusions and unwanted thoughts). The resultant items from this review and reorganization were then split into two formats – either spectrum items (those mental functions that could manifest as a spectrum from positive to negative) and problem items (those mental symptoms that represented purely detractors from overall mental well-being) – and formulated into a survey framework.

The analysis of 126 assessment tools resulted in 170 different symptom codings which were consolidated into a preliminary set of 43 symptom categories. Reviewing these 43 categories in the context of the MHQ format (see above), resulted in a final set of 47 items (Table 1).

Table1:
LIST OF "SPECTRUM" AND "PROBLEM" ITEMS

SPECTRUM QUESTIONS	PROBLEM QUESTIONS
Adaptability to Change	Restlessness & Hyperactivity
Self-worth & Confidence	Fear & Anxiety
Creativity & Problem Solving	Susceptibility to Infection
Drive & Motivation	Aggression towards Others
Stability & Calmness	Avoidance & Withdrawal
Sleep Quality	Unwanted, Strange or Obsessive Thoughts
Self-control & Impulsivity	Mood Swings
Ability to Learn	Sense of Being Detached from Reality
Coordination	Nightmares
Relationships with Others	Addictions
Emotional Resilience	Forgetfulness
Planning and Organisation	Anger & Irritability
Intimacy & Sexual Satisfaction	Suicidal Thoughts or Intentions
Memory	Experience of Pain
Social Interactions and Cooperation	Guilt & Blame
Decision-making & Risk-taking	Hallucinations
Curiosity, Interest & Enthusiasm	Traumatic Flashbacks
Energy Level	Repetitive or Compulsive Actions
Emotional Control	Feelings of Sadness, Distress & Hopelessness
Focus & Concentration	Physical Health Issues
Appetite Regulation	Confusion or Slowed Thinking
Empathy	
Sensory Sensitivity	
Self-image	
Outlook & Optimism	
Selective Attention	

2.1.3. QUESTION FORMAT

Twenty-six of these items were formulated into spectrum questions and 21 of these items were formulated into problem questions. Questions were answered based on the current perception of the respondent (“Please choose your answers based on your current perception of yourself”). Figure 2A shows an example of a spectrum question from the MHQ and Figure 2B shows an example of a problem question.

“Spectrum” questions were designed to reflect functions which could be an asset for some individuals but a problem for others. In this way, spectrum questions were developed so they did not relate to the presence or absence of a function/symptom, but instead focused on the positive or negative impact that the item had on the individual. Each question included a broad category label, as well as a one sentence description of the item for clarity. Spectrum items were rated on a 9 point scale where 1 referred to “Has a constant and severe impact on my ability to function effectively”, 5 referred to “Sometimes I wish it was better, but it’s ok” and 9 referred to “It is a real asset to my life and my performance”.

“Problem questions” were designed to reflect functions or dysfunctions that typically had a negative impact on someone’s life and could rarely be seen as a positive asset. Each question included a broad category label, as well as a one sentence description of the item for clarity. Problem items were designed to be rated on a 9 point scale where 1 referred to “Never causes me any problems”, 5 referred to “Sometimes causes me difficulties or distress but I can manage” and 9 referred to “Has a constant and severe impact on my ability to function effectively”.

Within the spectrum and problems sections of the assessment tool, questions were presented in random order so as not to be leading or priming for the subsequent question.

Figure 2:
EXAMPLE QUESTIONS FROM THE ASSESSMENT

(A) Example of a “spectrum” question.

Each question was composed of an item category and a 1 sentence description of that item, as well as a 1 to 9 rating scale with reference labels.

7→ Assess your: Adaptability to Change

*“Your ability to be flexible when faced with societal changes, or changes in your daily routine or environment, and to adopt new ways of living or working accordingly”**

Look at the **scale below**. Choose a number of stars between **1 and 9** which represents your **adaptability to change**.



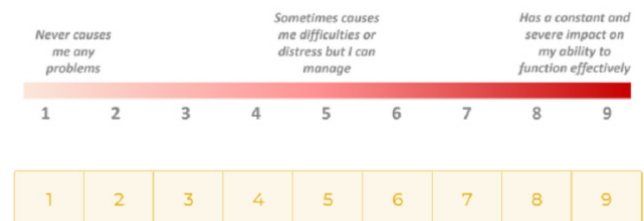
(B) Example of a “problem” question.

Each question was composed of an item category and a 1 sentence description of that item, as well as a 1 to 9 rating scale with reference labels.

33→ Assess your: Restlessness & Hyperactivity

*“The experience of being so fidgety or active that you are unable to relax or be still, even when it is required”**

Look at the **scale below**. Choose a number between **1 and 9** which represents your **restlessness & hyperactivity**.



2.1.4 DEMOGRAPHIC, EXPERIENCE AND MOMENTARY QUESTIONS

Questions designed to collect demographic, experience and momentary information were also included in the MHQ assessment. These questions aimed to provide insight into the life context and situation of the individual at the time of taking the assessment in order to understand how they influence mental health and well-being. Demographic questions were included to ask about the nature of a person's daily occupation, geography, age and gender. Momentary assessments were designed to determine certain aspects of the individual's situation, as well as their physical and mental state at the time of taking the assessment including alertness, mood, hours slept the previous night, time since last meal and any current physical symptoms such as headache, nausea or pain. Experience questions were included to ask about life satisfaction, life trauma, whether they had a diagnosed medical disorder or whether they were currently seeking mental health treatment. These questions were answered using multiple choice answer options, 9-point rating scales, or using a text box depending on the specific question type.

2.2 Scoring and reporting of the MHQ

2.2.1 COMPUTING OF THE MHQ

The MHQ was not computed as a simple average of raw scores given (1) there were both negative and positive aspects, (2) there are differences in the seriousness of consequences of different symptom types and (3) consequences do not necessarily increase linearly at higher values on the scale. Therefore, the raw scores were transformed in two steps which included a rescaling to positive-negative scales and the application of a nonlinear weighting that amplified the negative scoring of more negative rating responses in order to better distinguish at-risk populations.

For problem questions, responses on the rating scale were transformed to $N - [\text{rating response}]$ where N was a number between 2 and 6 that was selected depending on the seriousness of the particular

symptom (with lower numbers depicting greater seriousness). Thus, if N was 2, a rating response of 1 (representing the absence of the problem) would be rescaled to a 1 and a rating response of 9 (representing a constant and severe impact on the ability to function effectively) would be rescaled to -7. If N was 4, a rating response of 1 would be rescaled to a 3 and a rating response of 9 to -5. For spectrum questions the scores were rescaled as $[\text{rating response}] - N$ where N was a number between 2 and 6. Thus if N was 3, a rating response of 1 (representing a constant and severe impact on the ability to function effectively) would be rescaled to a -2 and a rating response of 9 (representing an asset to life and performance) to 6. In both cases N determines the threshold between positive and negative values where negative values indicate clinical risk while positive values represent normal ranges of functioning. Subsequent to this positive-negative rescaling, a differential nonlinear weighting was applied to negative scores of different symptoms to create greater distinction in the at-risk group. For example, a rescaled negative score of -7 for suicidal intent would be weighted more negatively than a -7 for restlessness and hyperactivity and therefore amplify the individual's risk more significantly.

The average of these negatively thresholded and non-linearly weighted scores across all problem and spectrum items was then computed. This average could be either a negative or positive score such that respondents who required clinical intervention or support were given negative scores and were more easily identifiable in the population, while positive scores represented a normal range of mental well-being. To compute the MHQ, positive scores were then normalized to a scale between 0 and 200 while negative scores were normalized across a smaller window of -1 to -100. The negative scale was chosen to be smaller in order to provide a mitigated number to minimize any psychological distress that could be induced by receiving a highly negative score. Thus, the overall MHQ score spans a possible range from -100 to +200 where negative scores reflect clinical or clinically at-risk populations, while positive scores reflect the distribution of the normal population.

2.2.2 MHQ SUB SCORES

Scores were also computed for 6 broad subcategories of mental well-being. These 6 categories included Core Cognition, Complex Cognition, Mood and Outlook, Drive and Motivation, Social Self and Mind-Body (Table 2).

To compute the subcategory scores, a weighted average of symptoms for each subcategory was calculated by weighting as “1” symptoms core to the subcategory and “0.5” symptoms secondary to the subcategory (e.g. Adaptability to Change was assigned a 1 for Complex Cognition and 0.5 for Drive and Motivation). This was done based on a review of cognitive and neuroscience models of brain functioning, and forms part of the proprietary algorithm. In this regard a symptom could be assigned to two different subcategories and occasionally three. Each subcategory comprised anywhere from 10 to 24 symptoms. The subcategory scores were then normalized to constrain them to a smaller scale than the overall MHQ to distinguish them from the overall score. Positive scores were normalized to the range of 0 to 50 while negative scores were normalized to the range of -1 to -50.

Table2:
DESCRIPTIONS OF THE 6 CATEGORIES OF MENTAL WELL-BEING

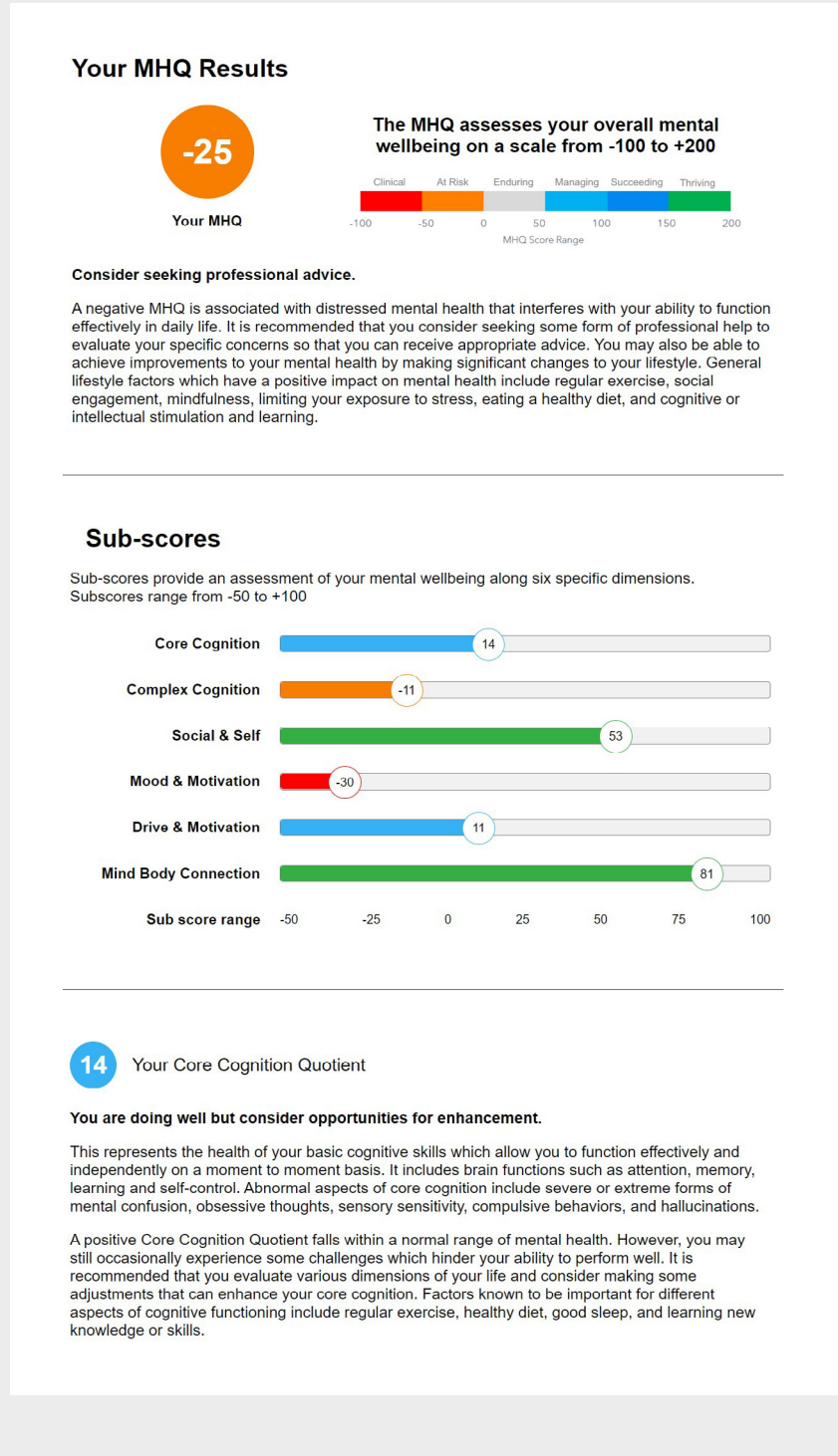
CATEGORY - Description
CORE COGNITION The ability to function effectively and independently on a moment to moment basis. Includes brain functions such as attention, memory, learning and self-control. Abnormal aspects of core cognition include severe or extreme forms of mental confusion, obsessive thoughts, sensory sensitivity, compulsive behaviors, psychosis and hallucinations.
COMPLEX COGNITION The ability to synthesize and make sense of complex sets of events and situations and display a longer-term perspective in thoughts and behavior. Includes brain functions such as decision-making, creativity, problem-solving, planning and adaptability to change. Abnormal forms of complex cognition are associated with extreme risk-taking and a severe intolerance to change.
MOOD AND OUTLOOK The ability to manage and regulate emotions effectively and encompasses feelings of distress such as fear, anxiety, anger, irritability, guilt and sadness. It also includes the ability to have a constructive or optimistic outlook for the future. Abnormal forms of emotional functioning include uncontrollable crying, night terrors, severe temper outbursts, extreme phobias, uncontrollable panic attacks, highly traumatic flashbacks, intense mania or suicidal intentions.
DRIVE AND MOTIVATION The ability to achieve desired goals and to initiate, persevere and complete activities in daily life. It is associated with interest, curiosity, motivation, and is also related to overall energy levels. Abnormal forms of drive and motivation include severe addictions which cause harm, or extreme withdrawal from activities or social interaction.
SOCIAL SELF The ability to interact with, relate to and see oneself with respect to others. It includes factors such as confidence, communication skills, self-worth, body image, empathy, and relationship building. Abnormal forms of social functioning include excessive unprovoked aggression, a strong sense of being detached from reality or suicidal intentions.
MIND-BODY The regulation of balance between mind and body to ensure that any mental concerns do not manifest themselves as physical symptoms in the body in a chronic or severe way. It includes functions such as sleep, appetite, coordination, sexual satisfaction and fatigue. Abnormal forms of mind-body balance can include insomnia or chronic and severe pain, as well as a propensity for infection or frequent physical symptoms (e.g. digestive issues) with no obvious physical cause.

2.2.3 INDIVIDUALIZED REPORT

The output of the MHQ was summarized both as scores as well as into an optional detailed report with recommendations for action that could be obtained by the respondent. Providing a detailed report ensured greater interest of the respondent to answer questions thoughtfully and accurately. Figure 3 shows an extract of an example MHQ results report detailing the MHQ score and subscores. The first section offers an overall MHQ score and a recommendation based on that score. The following sections offer scores for each of the 6 categories (Table 2) and recommendations based on each of those scores (see [19] for further details).

Figure 3: EXTRACT OF AN EXAMPLE MHQ RESULTS REPORT

The report details the overall MHQ score and recommendations based on that score. It also details each of the 6 subcategory scores as well as descriptions and recommendations based on each of those subcategory scores (not shown here, see [19]).



3. TESTING OF THE MHQ IN THE GENERAL POPULATION

3.1. Participant and protocol for data collection

One thousand one hundred and ninety-eight respondents took part in the study. Respondents were recruited from the online websites of Psychology Today and Sapien Labs using a series of blog articles targeted at adults during July-September 2019. The study received ethics approval from Health Media Lab Institutional Review Board. Respondents took part by accessing the MHQ online [19] and completing the assessment. Those under 18 years old were not eligible to take part. On average, the survey took 14 minutes to complete with the typical time taken for completion being between 8 and 20 minutes (79% of respondents). In addition, 99.5% of those taking part said the assessment was easy to understand.

3.2. Data cleaning and exclusion criteria

The following exclusion criteria were applied to the responses for data cleaning purposes. Firstly, the exclusion of all but the first of multiple assessments from the same IP address. Secondly, those respondents who took under 7 minutes or over 1 hour to complete the assessment. Thirdly, individuals who found the assessment hard to understand (i.e. responded “No” to the question “Did you find this assessment easy to understand?”). Fourthly, respondents who made unusual or unrealistic responses (e.g. those who stated they not eaten for 16+ hours, or who stated that they had slept for +16 hours). This resulted in the exclusion of 15% of responses and a total of 1017 responses available for the final analysis.

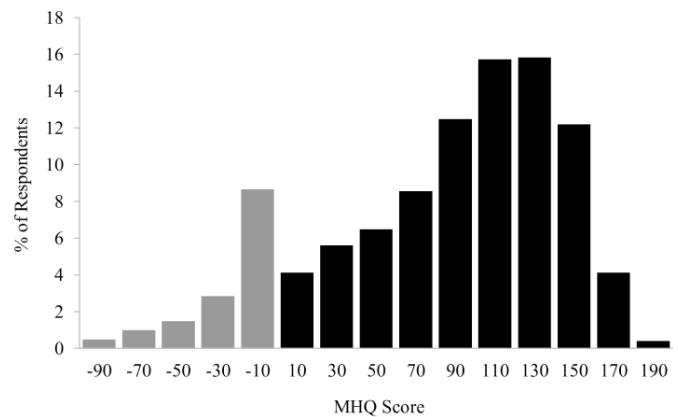
3.3. Respondent profile

Sixty-three percent of respondents were female, 35% of respondents were male and 1% responded as non-binary/third gender. One percent of respondents preferred not to reveal their gender. The age distribution of respondents ranged from 18 to above 65 with the highest number in the 25-34 age bracket (see Figure 5B legend for n values by age group). Only six percent of respondents were aged 65 or above.

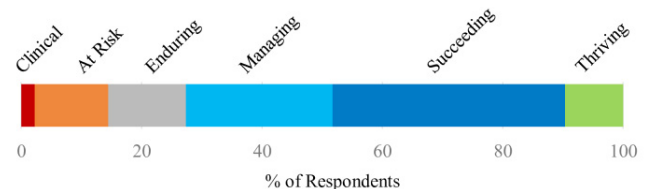
Respondents from 74 different countries completed the survey. The majority of respondents were from the United States (52%), whilst a notable proportion from UK (9%) and Canada and India (both 4%) also responded.

Figure 4: DISTRIBUTION OF MHQ SCORES ACROSS 1017 RESPONDENTS.

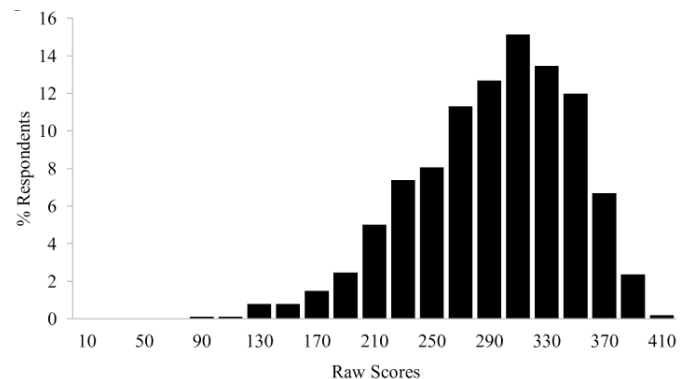
(A) Percentage of respondents falling into MHQ score windows ranging from -100 to +200. Grey bars denote negative scores, black bars denote positive scores.



(B) Percentage of respondents falling into each of 6 levels of MHQ scores. These levels are (from left to right) Clinical (Score range: -100 to -51), At Risk (-50 to -1), Enduring (0 to 50), Managing (51 to 100), Succeeding (101 to 150) and Thriving (151 to 200).



(C) Distribution of raw scores depicting percentage of respondents falling into different raw score brackets. Raw scores calculated as the average of spectrum question rating responses and reverse scored problem question rating responses (i.e. where 1 is converted to a 9 and vice versa to maintain a consistent positive-negative direction).



3.4. Overall MHQ scores

Firstly, we examined overall MHQ scores across the group of 1017 respondents. MHQ scores ranged from -99 to +188 (on a scale of -100 to +200) where 86% of scores fell within the positive or normal range and 14% fell within the negative or at-risk range. The distribution is shown in Figure 4A. The overall MHQ scores had an average of 83 (median 98) while the positive MHQ scores had an average of 101 (median 106.5, mode 140) and the negative MHQ scores had an average of -24 (median -15). To obtain an interpretative picture of these scores, we further grouped MHQ scores into six levels according to their score window (Figure 4B) where, in the positive score range +151 to +200 was considered thriving (10% of respondents), +101 to +150 was considered succeeding (39% of respondents), +51 to +100 was considered managing (24% of respondents) and 0 to +50 was considered enduring (13% of respondents). In the negative range 12% of respondents fell in the -1 to -50 score range and therefore would be considered at risk for a mental health disorder while 2% of respondents fell in the -51 to -100 range, representing those who would likely require immediate clinical intervention.

There were certain important characteristics of the distribution of MHQ scores. First, the scale spanned both positive and negative numbers and the distribution was more heavily skewed to the left compared to a simple average of the raw scores (Figure 4A in comparison to Figure 4C). This reflects the characteristics of the algorithm (negative thresholding and nonlinear weighting, see Methods section 2.2) which serves to create greater distinction between people who have negative symptoms of different levels of seriousness and life consequence. Second, there was a peak in the negative range in the bin immediately to the left of the zero. This arises on account of the compression of the negative scores to a smaller scale of 50% of the positive scale such that each bin would be double what it would otherwise be. The rationale for this differential was to mitigate stress to the respondent.

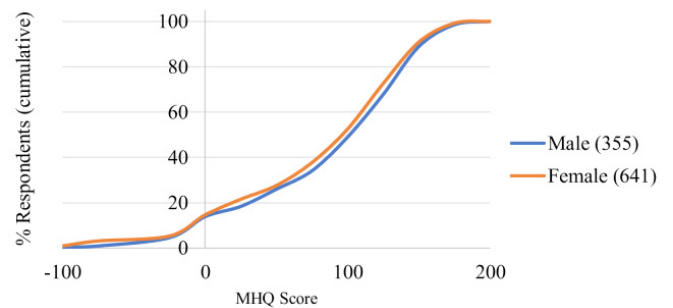
3.5 MHQ by age and gender

We next show the initial results of overall MHQ scores by age and gender (Figure 5). The distribution for males and females were essentially similar (Figure 5A) with similar proportions of respondents reporting MHQ scores in the negative range (14% for males, 15% for females). In contrast, MHQ scores differed substantially by age, with higher age brackets having increasingly positive

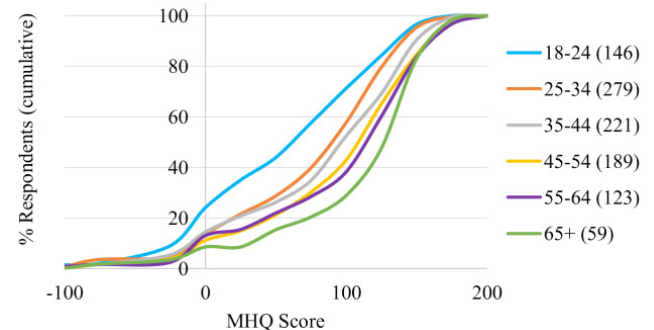
scores overall (Figure 5B). MHQ scores of respondents in the 18-24 age range were sharply lower, with 24% in the negative at-risk range and only 29% succeeding or thriving (Figure 5C). The proportion at-risk declined with age from 24% to just 8% in the 65+ age group and the proportion succeeding or thriving (i.e. scores above 100) increased with age from 29% to 71%.

Figure 5: DISTRIBUTION OF MHQ SCORES ACROSS GENDER AND AGE.

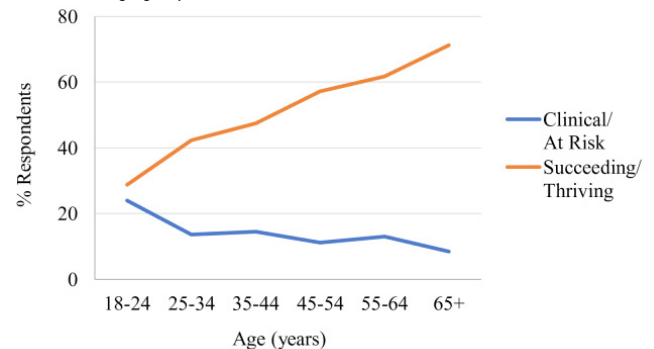
(A) Cumulative percentage of respondents across the MHQ score range for male and female groups. N values for male and female groups shown in legend.



(B) Cumulative percentage of respondents across the MHQ score range for each age bracket. N values for each age bracket shown in legend.



(C) Linear increase in proportion of Succeeding/Thriving (MHQ scores above 100) and decrease in proportion of At-Risk (MHQ scores below 0) from younger to older age groups.



3.6 MHQ subcategory scores

We next show the distribution of MHQ subcategory scores across each of the 6 subcategories of mental well-being (Figure 6). The distribution structure has high similarity to the overall MHQ across all categories with a normal distribution in the positive range and a skew in the negative range (Figure 6A).

The average values across the entire score range for each subcategory were as follows:

- Core Cognition: 47 (median 55);
- Complex Cognition: 49 (median 54);
- Drive and Motivation: 47 (median 54);
- Mood and Outlook: 39 (median 45);
- Social Self: 40 (median 49);
- Mind Body: 41 (median 46).

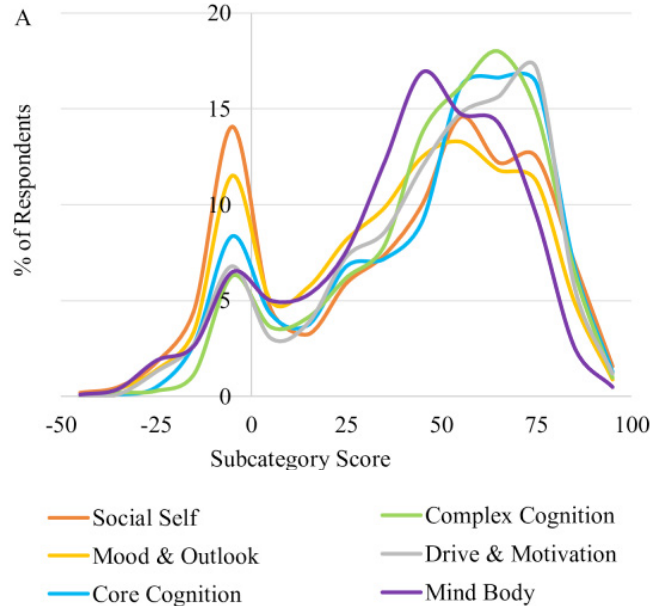
Within the positive score range the average, median and modal values were as follows:

- Core Cognition: 55 (median 59/mode 59);
- Complex cognition: 54 (median 57/mode 50);
- Drive and Motivation: 54 (median 57/mode 70);
- Mood and Outlook: 49 (median 51/mode 53);
- Social Self: 53 (median 56/mode 58);
- Mind Body: 48 (median 49/mode 48).

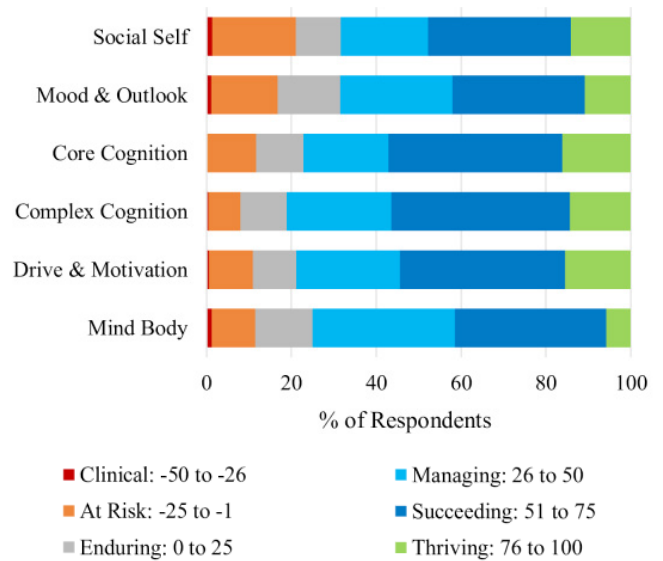
A few key aspects warrant mention: the Social Self category in particular had a comparatively large proportion of people in the negative range (21% overall, 1.4% in clinical range) followed by Mood and Outlook (17%, 1.1% in clinical range) indicating that challenges relating to these aspects of mental well-being were most highly prevalent in the population of respondents (Figure 6B). In contrast the proportion of respondents facing serious challenges in their Cognition (Core and Complex), Drive and Motivation and Mind Body were comparatively smaller.

Figure 6: DISTRIBUTION OF MHQ SUBCATEGORY SCORES

(A) Distribution of MHQ subscores for each of the 6 subcategories of mental well-being.



(B) Percentage of respondents for each of the 6 subcategories of mental well-being for each MHQ score level. These levels are (from left to right) Clinical, At Risk, Enduring, Managing, Succeeding and Thriving. Numbers in legend denote MHQ score range for each level.



4. DISCUSSION

The momentous task of trying to alleviate the burden of mental health can be approached in two ways. The first involves an individual-based approach where the aim is to remedy and treat the symptoms of the individual. The second is a population-based approach which aims to reduce the overall number of people who experience those symptoms. Over recent years it is the former approach that has dominated clinical research and practice, motivated by a desire to deliver more personalized approaches to mental health treatment and intervention which are specifically aligned with patterns of observed symptoms and precision-based research approaches which target specific physiological or genetic profiles [3-5]. However, population approaches are equally valuable, as they offer the opportunity to instigate a downward shift in the prevalence of mental health challenges across an entire population by revealing social and environmental risk factors, as well as identifying at-risk groups [6-9,23]. Here we present the MHQ, a uniquely designed disorder agnostic online assessment tool, that serves both purposes of providing a population and individual view of mental well-being and dimensions of distress.

4.1. *MHQ as a unique and comprehensive view of both well-being and mental distress*

The MHQ spans the breadth of mental health symptoms associated with major psychiatric disorders in a standardized and unbiased manner and covers assets and abilities important for overall well-being. The fact that 99.5% of respondents found the MHQ easy to understand, and that it took, on average, only 14 minutes to complete, indicates that the tool was highly accessible to the general population.

The MHQ was uniquely developed based on an extensive review of symptoms across 10 different mental health disorders, as well as taking into account disorder agnostic approaches to mental health (e.g. RDoC [20-22]). In this regard it fills a unique space given that existing mental health assessment tools are often specific to one (or sometimes two) disorders and, where they do offer a cross-disorder perspective, are

incomplete across the landscape of mental health and well-being, are biased in their approach to symptom assessment (e.g. an unbalanced focus on thoughts vs feelings vs behavior), and are often formulated as a clinical interview which is not accessible to the general population [16]. The MHQ also goes beyond disorder-based approaches with the inclusion of “spectrum” items that give consideration to a person’s abilities and assets. This aspect, rarely considered by existing mental health assessment tools, is critical to established views of mental health [1] and captures the growing realization that positive aspects of mental health are essential for an integrated view of health [2,24].

Together, this design approach allows respondents, on an individual level, to obtain a holistic picture of both concerns and abilities across their results profile while, from a population level, it ensures that insights are not based on an incomplete or biased picture of reported symptoms and functions.

4.2. *Insights into individual mental well-being*

On one hand, the MHQ can be used to provide a personalized insight into an individual’s mental health and well-being in a manner that is disorder agnostic and avoids the ambiguity of disorder classification [18]. These insights are accompanied by feedback generated based on the scoring profile of the individual. This allows at-risk individuals to self-identify so that they can seek appropriate support before reaching clinical levels of distress or impairment. For example, in this preliminary dataset, 12% of respondents were identified as being at risk, while 2% likely required immediate clinical intervention. It also provides a mechanism for individuals within a normal healthy range to evaluate dimensions of their mental well-being and identify challenge areas so that they can take action (e.g. make adjustments to their lifestyle) to strengthen and preserve their well-being even if they are not considered clinically at-risk. The MHQ can also be used as a fast patient screen on admittance to a hospital clinic where individual scores can provide an initial impression of a patient’s symptoms prior to more detailed evaluations.

4.3. *MHQ as a population assessment tool*

The MHQ was also designed to be easy to implement in research initiatives employing large populations of individuals to obtain insights into the profile of mental health and well-being challenges. Here, relating the MHQ scores to a range of demographic, experiential and situational variables can support the development of relevant interventions or policies that can induce larger-scale shifts in population well-being. Furthermore, when the MHQ is used with a group of individuals, it can be used to support the design of tailored interventions suited to that specific group, identify at risk individuals or subgroups, and assess the impact of any interventions. The results obtained from the MHQ can also be used to relate the scoring profiles of a known clinical population to different physiological aspects or clinical therapies, to determine the efficacy of new treatment regimes.

Demonstrating its relevance as a population assessment tool, the preliminary data presented here from just 1017 adult respondents, demonstrated, for example, that individuals within the youngest age bracket (18-24 years) were most at risk from experiencing mental health challenges, something also in line with data from other sources [25]. While this preliminary dataset is insufficient for deep population insights into the drivers of mental health and well-being, when administered on a larger scale the MHQ can both deliver such insights and serve as a tool to measure the impact of social interventions on overall population.

4.4. *Identifying the borders between “abnormal” and “normal” mental health*

The development of an assessment tool that covers the breadth of mental health and well-being, and that is accessible to the general population is also relevant for one of the major discussion points pertaining to the diagnosis and classification of mental disorders, namely the distinction between “normal” and “abnormal” mental health [12,14,15]. As most negative mental states, such as sadness, despair, anxiety, fear, agitation, and anger, are not abnormalities per se but normal responses to life’s ups and downs, being able to decipher whether a person is responding normally to difficult circumstances, or experiencing pathological levels of distress or impairment, is not straightforward [13]. One challenge underpinning this debate, relates to the fact that, currently, there is a

poor understanding of the state and diversity of mental health and well-being across a “normal” population. Thus, if there is a poor understanding of what the continuum of “normal” mental health looks like, how can we understand when it is starting to slide into “abnormal”. Such a distinction is necessary not only to prevent false positives in diagnosis, a label that can be unduly associated with stigma, but also to ensure that people receive appropriate treatment, and that clinical research studies investigating underlying etiologies select from appropriate sample pools. The MHQ assessment tool has been constructed to capture this breadth of function from positive assets to extreme distress in order to establish these distinctions.

With psychiatric disorders being among the most disabling health conditions worldwide and creating significant burdens on individuals and societies [26], assessments of mental health and well-being that are accessible to the general population support the early identification of at risk individuals or subgroups and reveal relevant risk factors. This, in turn, can help to reduce the burden of suffering by facilitating the development of relevant and effective interventions and policies before symptoms escalate to clinical levels. The importance of population-accessible tools is further emphasized by the reported gap between those suffering from severe distress and impairment, and those receiving the help and support they need [27]. The MHQ aims to help realize the vital goals of mental health prevention and support by providing a means to measure and track population mental health and well-being. Going beyond this, the MHQ ultimately seeks to enable a paradigm that can manage and improve the lives and well-being of all people, and not just of those with disorder or dysfunction.

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6. CONFLICTS OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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