

Psychometric properties of a novel burnout assessment instrument: Individualized Burnout and Contributors Scale (IBOCS)

Jim Hudziak

University of Vermont College of Medicine

Zoe Morrell (✉ zoe@happy.ai)

Happy Health <https://orcid.org/0000-0001-6913-3352>

Nicholas J. Schork

UCSD: University of California San Diego

Arnulf Graf

Happy Health

Lucy Lincoln

Happy Health

Sue Smalley

UCLA: University of California Los Angeles

Dustin Freckleton

Happy Health

William E Copeland

University of Vermont College of Medicine

David Rettew

University of Vermont College of Medicine

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Abstract

Background: Self-report of burnout is important in understanding how individuals are coping with the stress in their lives. Traditionally, burnout has been measured as a factor of work-related stress. However, with increasing reports of burnout related to areas of life outside of work among teens and young adults, the need has developed for a more comprehensive burnout measure targeted to a younger population. This study introduces the Individualized Burnout and Contributors Scale (IBOCS), an instrument designed to be administered on digital devices, and comprised of two separate measures that evaluate overall burnout level and burnout contributors. The IBOCS is unique in that it aims to assess comprehensive burnout, focusing not only on occupational factors, but on other potential life stressors as well. Additionally, the IBOCS can be administered easily on digital platforms, which is especially important in engaging younger populations. Unlike many other existing burnout scales that are costly to administer and are scored manually, the IBOCS is intended to be used as a free, easily accessible tool that is aimed at empowering individuals to measure and monitor their burnout frequently.

Methods: A sample of 1,244 individuals completed an online survey battery that assessed contributors to burnout along with measures of wellbeing, perceived self-stress, and stress personality.

Results: Exploratory and Confirmatory Factor Analyses, Recursive Feature Elimination and regression analysis of the IBOCS burnout level items yielded a two-factor model with dimensions labeled: 1) Exhaustion; and 2) Fulfillment. Similar analyses of the IBOCS burnout contributor scale yielded a two-factor model with dimensions labeled: 1) Negative; and 2) Positive. Our analyses reveal evidence of multiple contributors to burnout including struggles with personal relationships, health concerns, time spent in the digital space, financial worries, and work or school-related stresses. Subsequent correlation analyses suggested strong convergent validity between the IBOCS and established rating scales of perceived self-stress, stress personality, happiness, and overall wellbeing.

Conclusion: We conclude that the IBOCS has solid psychometric foundations and reflects important characteristics of burnout and burnout contributors. The implications of this work are discussed in the context of positive psychology to help individuals interrupt the progression of burnout in their lives.

Introduction

Stress is now well recognized as a primary causal factor in the development of emotional, behavioral, and general medical health problems [1]. It is now generally accepted that the vast majority of human illnesses are related to, and often exacerbated by, the amount of stress an individual endures [2]. Recently, the COVID-19 pandemic has highlighted the importance of coping with health, relational, financial, social, and familial stress factors [3]. How individuals manage their life stress is an increasingly important determinant in whether a person feels valued, healthy, and successful, versus feeling burnt out [1, 4].

Historically burnout research has been focused on the workplace [5], but the modern study of burnout has evolved to encompass all major aspects of life. Our team has extensively studied the impact of stress on

college-age students throughout COVID-19 and has identified that while many of these young adults have reported symptoms of burnout, the contributors to burnout are not related to the workplace [6, 7].

A Google Scholar search using the term 'burnout' yields 1,250,000 results. The same PubMed search yields over 20,000 peer reviewed publications in top scientific journals. A review of this literature demonstrates the important role of stress-related burnout stemming from relationships [8, 9], parenting [10, 11, 12], time spent in the digital world [13, 14], health concerns [15], financial concerns [16, 17], and more traditional stress attributable to work- and/or school-related factors [18, 19, 20]. Recent research also suggests that stress-related burnout is common among those of the Millennial generation who are just entering the workforce, and among individuals still in high school and college (i.e., "Generation Z") [21, 22, 23, 24]. Furthermore, it is important to note that increased levels of stress-related burnout have been reported in the workforce as workers navigated the added stress of transitioning to remote work or returned to in-person work during the COVID-19 pandemic [25]. Overall, the prevalence of stressors in our modern world and the associated reports of burnout have left some to ponder the question "Burnout: Modern Affliction or Human Condition?" [26].

To better understand that question, it is necessary to develop a method that assesses not only an individual's level of burnout, but also the contributing factors that inform an individual's unique experience of burnout. We aimed to develop an instrument comprised of two separate scales that comprehensively measure burnout and its contributing factors: the Individual Burnout and Contributors Scale (IBOCS). A literature review was conducted to evaluate the most used burnout evaluation tools. Based on the literature review findings, questions were developed to measure an individual's current burnout level, and separately, to assess the contributors to burnout an individual may be experiencing, of multiple sources of burnout, not just work-related stress. Additionally, items were designed with the intent of tapping into burnout-related stressors in the evolving digital world of peri- and post- pandemic life.

The original items of the IBOCS were created by the authors with several goals in mind. The first goal was to create a platform for younger populations to learn about the role of stress and burnout in their lives, simply by entering responses on their phones. This goal is important, as individuals who grew up in the digital age are reporting epidemic levels of stress-related burnout symptoms across all major areas of life [24]. Unlike many other existing burnout scales that are costly to administer and must be scored manually, the IBOCS was developed as a free tool that can be administered and scored digitally, allowing the respondent to easily measure and monitor their personal burnout frequently.

The second design goal for the IBOCS was to evaluate and learn from the myriad of existing burnout inventories and apply modern psychometric analyses and machine learning approaches to the development of a streamlined, yet valid, burnout scale that evaluates burnout level and assesses contributors to burnout. Several instruments designed to assess burnout were reviewed, including the Maslach Burnout Survey, the Oldenburg Burnout Inventory, the Single-Item Burnout Measure, the Copenhagen Burnout Inventory, the Burnout Assessment Tool, and the Stanford Professional Fulfillment Index [27, 28, 29, 30, 31, 32]. These instruments capture burnout related feelings and behaviors across a

variety of domains including work and school responsibilities [1, 4, 8, 16, 27, 28, 29, 30, 31, 32], personal health [8, 9, 16, 27, 28, 29, 30, 31, 32], social support [3, 4, 29, 30], digital health [13, 14], and financial resources [16, 17].

This study reports our initial work on the development of a new instrument, the IBOCS, which is comprised of a comprehensive burnout scale and a separate burnout contributors scale, designed to be collected easily on digital platforms. We hypothesized that we could develop an instrument with strong psychometric properties which exhibit significant associations with existing validated measures of stress, stress personality, and wellbeing.

Methods

Initial IBOCS Construction

Based on the primary goals of instrument development previously discussed, an initial consensus-developed 22-item IBOCS was created, consisting of 9 burnout measures (Table 1) and 13 burnout contributor measures (Table 2) to which a respondent would rate their level of agreement on a 5-point frequency scale as follows: 1) Never; 2) Rarely; 3) Sometimes; 4) Often; and 5) Always. The items used in the IBOCS were distributed so that statements hypothesized to load onto different dimensions were spread evenly throughout the instrument and not clumped together.

Study Participants

Survey data were collected from 1,244 participants who completed the online survey battery but were recruited using two primary methods: through the paid crowdsourcing services Amazon Mechanical Turk and QuestionPro Audience, and through a follow-up email sent to individuals who had previously responded to a separate survey. Respondents completed the survey with no personally identifiable information, although optional contact information was collected and stored in a separate file for those interested in a raffle drawing or interested in being contacted regarding future research opportunities. The study protocol was approved by commercial vendor Solutions Institutional Review Board (IRB). These data were obtained in the winter and spring of 2021 while the COVID-19 pandemic remained responsible for high rates of hospitalization and death, as well as continued educational and workplace disruption.

Additional Measures

In addition to the 22-item IBOCS, the following rating scales were also administered for comparison and validity analyses.

Stress: Subjectively related stress levels were assessed using the Perceived Stress Scale (PSS) [8, 9]. For the 10-item PSS, respondents indicate on a scale of 0 to 4 how often in the past month they have

experienced various types of stress. These items are summed to create an overall stress score.

Short Warwick Edinburgh Mental Well-Being Scale (SWEMWBS): The short version of the Warwick-Edinburgh Mental Well-Being Scale (SWEMWBS) was used to assess overall well-being. This well-tested instrument contains 7 positively worded items in areas such as feeling useful and thinking clearly [33]. Respondents rate how often they experience these items on a 1 to 5 scale and a total sum score is calculated.

Stress Personality: Previously, our group reported on a modern stress personality scale that is currently under review, the Virtual Inventory of Behaviors and Emotions (VIBE), that revealed 4 domains, one of which was labeled the Stress Personality Factor. This 10-item stress factor (Table 6) contains items that directly ask about one's propensity to experience and cope with stress, rumination about negative comments and interactions, and having doubts about one's ability to be successful.

Analyses

Exploratory Factor Analyses and Confirmatory Factor Analyses of IBOCS Items

The initial 22-item IBOCS (Table 1, Table 2) were first subjected to Exploratory Factor Analyses (EFA). Maximum likelihood based EFA with varimax rotation was used to explore the factor structure of the burnout and contributors' items, as well as each item's loading on resulting factors [34,35] pursued the same analyses on the Perceived Self Stress measure (PSS) which revealed two PSS factors, labeled PSS1 and PSS2 here after. The R computing environment package 'Psych' was used to carry out the analyses [33]. The number of factors to be used was based on several metrics, including factor eigenvalues > 1, examination of the scree plot, cumulative variance explained, and interpretability of the model [33]. Based on the results of the EFA, items were assigned to factors, with unnecessary or poorly loading items removed based on a threshold of 0.59. Following preliminary analyses and machine learning-based item reduction analysis, a battery of 16 items were chosen: 6 items reflecting level of burnout (Table 3) and 10 contributing items (Table 4). The final structure was then subjected to Confirmatory Factor Analysis (CFA) with the acceptability of the model examined using a number of standard goodness-of-fit indices including Cronbach's alpha coefficient, the average correlation within a scale (also known as alpha 1), the correlation of each item with each scale, the simple signal to noise ratio (i.e., $n \cdot r / (1 - r)$ where r is the average item-specific correlation for a factor), and the intercorrelation of all the scales, again using the Psych package in the R environment.

Machine Learning Item reduction of IBOCS items

The data from 1244 subjects responding to the 9 burnout (Figure 1) and 13 contributor questions (Figure 2) were analyzed by ranking the importance of the items (also referred to as features in machine

learning) relative to a reference set of questions (PSS, PSSF1+PSSF2 or VIBE10+2PSS) using Recursive Feature Elimination (RFE) [36]. RFE recursively removed the least important feature (item) with respect to a cost function. This process therefore assesses the predictive power of the remaining set of features collectively. Specifically, we predicted the subjects' scores corresponding to the reference set of questions (PSS, PSSF1+PSSF2 or VIBE10+2PSS) based on the subject's scores to the burnout or contributor questions. For regression, we used a combination of linear, ridge, and Lasso regression [37]. to predict the reference set based on the IBOCS items, ultimately computing the correlation between the true and predicted values of the reference set. We then computed the correlation between these predicted scores and the true scores. This correlation coefficient was our cost metric. The larger the value of the cost function, the more predictive power was associated with the set of features used for this inference. We computed RFE using this cost metric and obtained for each burnout item a rank and a score. Scores ranged between 0 and 1, except for the second row where we separately predicted the ranking against PSSF1 and PSSF2 and combined both rankings (hence possibly creating a score larger than 1). Following factor analyses and machine-learning examination, we chose to remove three questions from each of the two original burnout scales based on their absolute and relative scores across the three reference sets.

Latent Class Analyses

To identify empirically-based clusters of individuals with similar profiles across the burnout items to best understand if there are groups who experience stress in similar ways, we completed Latent Class Analysis (LCA) on the 6 burnout and 10 contributor item-sets. Polytomous variable LCA was performed on the 6 burnout items as well as the 10 contributor items using the poLCA package in R [38,39,40]. The optimal number of latent classes was chosen based on minimum Bayesian Information Criterion (BIC) produced over models that assumed 2 to 10 latent classes [41].

Correlation Analyses

Finally, convergent validity of the final version of the IBOCS was tested by calculating correlation coefficients with widely used and validated measures of stress personality, perceived self-stress and wellbeing as described above.

Results

Demographic Information

The demographic information for the study's 1,244 subjects is shown in Table 5. Almost half (53.4%, 788) of the total sample consisted of young adults between the ages of 12 and 34. Regarding gender, a total of 54% of the total sample identified as female while 2.6% reported a non-binary or genderqueer identity. Slightly over 2% of the sample came from outside of the United States.

Exploratory Factor Analyses

EFA of the 6 burnout items suggested that two factors could explain 54% of the variation in the item correlation matrix. Table 8 provides the factor loadings. The first 3 eigenvalues of the matrix were 2.68, 1.44, 0.61, consistent with the presence of 2 factors (a simple scree plot revealed diminishing eigenvalues <1.0 beyond the first 2 eigenvalues as well). Upon inspection, the first burnout dimension (BO1) consisted of three items reflecting subjects being emotionally and physically exhausted and having a negative attitude towards others and life. As a result, this dimension was labeled Exhaustion (EX). The second dimension consisted of the following items, all reversed scored: engaged and accomplished in what I am doing; valued as a person; and fulfilled in my daily life. As a result, this dimension was labeled Fulfilled (FX) Table 8 contains the factor loadings of the IBOCS 6 Burnout items.

For the IBOCS 10 burnout contributor items, EFA suggested that 2 factors could explain 45% of the item correlation matrix, with the first 3 eigenvalues being 3.69, 1.86 and 0.88 and the remaining eigenvalues all decreasing towards 0.0. The first factor consisted of items that describe factors of daily living that negatively impact an ability to cope with stress, such as worries about amount of time spent in the digital world and the need to cut down on phone usages, work and school demands, lack of interest and enthusiasm about work and school, worries about general health, worries about physical and emotional wellbeing, and financial concerns. The second factor consisted of positive items, which were reverse scored, such as having enough social support, positive social interactions and having enough money to engage in leisure time activities. Thus, the two dimensions were labeled 'Negative (NEG)' and 'Positive (POS)' contributors. Table 9 provides the factor loadings for each dimension.

As an additional quality control step to test the validity of our data collection strategies, we also pursued EFA on the often-used PSS scale given the nature of the items and their relations to our IBOCS scales. Consistent with prior work, our EFA revealed a two-factor structure (Table 10), one factor consisting of adaptational items, and the second consisting of items associated with stress coping mechanisms. The results of these analyses gave us confidence that our convergent validity/correlational analyses were consistent with other analyses and scales discussed in the literature.

Confirmatory Factor Analyses

The CFA focused on the individual factor loadings (>0.3 or <-0.3) and the internal consistency of the items (i.e., their correlations with the factors and other items contributing to a factor, see Methods). Results suggested that the IBOCS's factors continued to fit the data well.

Cronbach alpha coefficients for the of the 2 burnout factors were 0.75 and 0.79, with the average item correlations of 0.50 and 0.55 with signal-to-noise statistics of 3.0 and 3.7. For the 2 contributor factors, the Cronbach alpha coefficients were 0.85 and 0.66, the average item correlations were 0.45 and 0.44, and the signal-to-noise statistics were 5.6 and 2.0.

Machine Learning Analyses (Item Reduction Process)

Our data may indicate that the subjects were more reluctant to directly report burnout, validating our approach to assessing burnout in specific and discrete factors, instead of comprehensively. Life balance and meaning (the two other removed questions) also ranked low in our analysis, indicating that burnout was less related to the concepts reflected in these items. The remaining 6 burnout questions formed an independent set of questions quantifying burnout for the three chosen reference questions sets. With respect to the initial 10 contributor items, our analysis found that the three removed questions were *de facto* redundant with some of the remaining 10 questions, thus corroborating the strength and validity of our ranking approach (Figure 4). These results suggest that the remaining questions provide independent formulations for a specific stress contributor, and that reducing any of these sets further would alter the richness of our description of the origins of stress.

Convergent Validity/Correlation Analyses

Convergent validity for the IBOCS was tested by examining standard Pearson correlations between the IBOCS burnout and contributor factors and measures of stress personality (VIBE 10), perceived self-stress (PSS) – including the two PSS factors emerging from our EFA of the PSS scale – and reports of wellbeing (SWEMWBS). As shown in Table 7, several strong associations were found between these measures and the two dimensions of the IBOCS.

Specifically, with respect to the two burnout factors, EX and FX, higher scores on EX factor were positively and significantly correlated with the PSS1 factor and the VIBE 10 and correlated negatively with the PSS2 factor and the wellbeing measure, SWEMWBS. The FX burnout factor correlated in the opposite direction: higher scores on the FX items positively correlated with PSS2, wellbeing, and negatively correlated with PSS1 and the stress personality scores on the VIBE 10. For the two factors emerging from the IBOCS Contributor analyses, i.e., the NEG and POS contributors, a similar pattern emerged. Higher scores on the NEG (i.e., negative factor) correlated with higher scores on the PSS1 and lower scores on PSS2 and the VIBE 10 Stress Personality scale, and negatively correlated with the SWEMWBS wellbeing scale. For the POS factor the opposite was the case, with negative correlations found with the two stress scales, the PSS1 and VIBE-10, and positive correlations with the PSS2 and the wellbeing scale, SWEMWBS.

Latent Class Analyses

Latent Class Analyses was used to identify person-centered subgroup profiles for both the 6-item burnout and 10-item contributor sets of the IBOCS. The 6-item burnout scale was divided into 5 distinct classes, while the 10-item contributor scale revealed 6 classes. Although LCA generates classes made up of individual response profiles across the items, rather than factors that group the items across individuals, for both LCAs classes emerged that were consistent with the two factor models for both the burnout and contributor items. In other words, the burnout LCA revealed that individuals differ on their class

membership in the EX and FX burnout items. Similarly, yet less evidently, the LCA of the contributor items revealed 6 classes of individuals based on their memberships in the negative and positive item groupings.

For the LCA of burnout items, based on BIC values for each assumed number of latent classes from 2 to 10, the lowest BIC value was found for the 5 latent class model. Figure 1 provides a graphic representation of the 5 classes. Class 1, labeled 'Burnout-Free' class, consists of 7.8% of the individuals in the study. Individuals in this class had very low scores on the EX-items and very high scores on the FX items. In other words, they have low stress and report they are highly engaged, valued, and fulfilled. Class 2, labeled 'Mild Burnout,' made up of 12.5% of the sample and had slightly higher scores on the EX and slightly lower scores on the FX items. Class three, 'Moderate Burnout' is the largest group of individuals, representing 43% of the sample. Individuals in this group have moderately high scores on the EX and moderately lower scores on the FX items. In other words, they report emotional and physical exhaustion and negativity but also report relatively moderate levels of social support, fulfillment, and life values. Class 4, 'All High Class' is made up of 18.6% of the sample and this group had the highest scores on *both* EX and FX. These individuals have very stressful lives but also are highly engaged and supported socially. Class 5, 'High Burnout' Class, consists of 15.8% of the sample. This group has very high EX scores, reporting emotional and physical exhaustion and a negative attitude toward life, in addition to having the lowest FX scores of any of the participants in engagement, accomplishment, and fulfillment.

For the LCA of Contributor burnout items, our primary question was whether burnout came principally from work/school related stress or rather multifactorial contributors.

Figure 2 provides a graphic representation of the 10 Item Contributor LCA. LC1, 'Low Stress/High Support,' consists of 12.5% of the participants, scored very low on the negative contributor items and very high on the positive contributor items. LC2, 'Work/Health Stress/Mod Support,' consists of 24.4% of the participants. These individuals report higher contributor scores associated with school/work, physical/emotional health concerns, yet are bolstered by moderately high social support, interactions, and resources for fun. LC3, 'MOD Stress/MOD Support,' consists of 24.4% of the group, and unlike LC2, this group reported equal stressors from all contributing areas of life, while still enjoying moderate support. LC4, 'MOD High Stress/MOD High Support,' consists of 22.3% of the individuals in the study. These informants reported the second highest levels of stress contributors in all domains but also equally high levels of support. LC5, 'High Work/Health Stress, Low Support,' consists of 12.3% of the sample. Individuals in this group reported high levels of burnout contributions from concerns about work and health but unlike LC1-4 and 6, have very low scores on social support, interactions, and ability to afford fun. LC6, 'High/High,' the smallest group in the study at 4.2% of the sample, reported the highest scores in all negative contributor domains and the highest scores in all positive support domains.

Discussion

The results of our analyses must be understood in the light of some of our study's strengths and limitations. While our initial studies with the IBOCS were conducted with a large sample with good racial and geographic diversity, it needs to be tested with a more representative and rigorously recruited group, particularly in the context of establishing normative IBOCS scale values, as the reliability of personality data from sources such as Amazon Mechanical Turk have been questioned [45]. Additional tests to verify other forms of reliability, such as a test-retest, inter-rater, and construct validity also need to be performed to confirm the psychometric integrity and utility of the IBOCS instrument. Future research on the IBOCS instrument will include longitudinal data collection to establish construct validity and stability. It is also possible that the COVID-19 pandemic led to changes in the baseline levels of the IBOCS stress and contributor domains and their relations to other variables. Nonetheless, the IBOCS performed well on several both traditional and more modern psychometric analyses in the initial sample of 1,244 individuals.

Conclusions

This study introduces a new 16-item burnout measure, the IBOCS, which consists of two separate scales: a burnout symptoms scale and a burnout contributors scale. We evaluated the psychometric properties of the IBOCS using a sample of 1,244 individuals. The resulting IBOCS scales were also compared to validated and commonly used measures of stress and wellbeing. The IBOCS was created with two specific goals in mind: to create a scale that measured burnout from major areas of life stress; and to create a scale that could be easily administered on digital platforms. A long-term aim of this work is to use the IBOCS, in concert with other measures and strategies of health promotion and positive psychology, to help individuals gain improved insight and management of the stress in their lives.

Exploratory factor analyses on the IBOCS revealed two burnout dimensions (Exhausted and Fulfilled) and two Contributor Dimensions (Negative and Positive). Higher scores on the EX-dimension strongly correlated with higher scores on other measures of stress including the PSS1 and the VIBE 10 Stress Personality Scale. These data indicate our short form IBOCS correctly taps domains associated with experiencing high levels of stress. Further supporting the integrity of IBOCS, the EX is negatively correlated with high scores on the SWEMWBS, a measure of wellbeing. Taken together, these data demonstrate that the EX-dimension correlates with high levels of stress and lower levels of wellbeing, consistent with our general hypothesis and goals. The FX domain, made up of items of engagement, accomplishment, feeling valued, and feeling fulfilled, positively correlates with the PSS2 and the SWEMBS wellbeing index, and negatively correlates with both the PSS1 and VIBE-10, providing further evidence for the existence of a two-factor solution for the IBOCS burnout items. This two-factor solution from the burnout analyses maps nicely onto the work of others, [4] who report similar domains of exhaustion and diminished personal achievement and values. These findings are consistent with those reported by Hewitt, et al. who demonstrated a factor related to physical/mental exhaustion and a second factor associated with feeling valued using a different set of items [42]. Others, however, have argued that reports of diminished effectiveness are 'implicit' in the full burnout experience [43].

The factor structure of the 10 burnout contributor items provide evidence of two straightforward dimensions. The first dimension, negative contributors, is made up of 7 items of stress generated from being overwhelmed by concerns about health, relationships, work/school, digital health, and financial wellbeing. The second dimension, positive contributors, is made up of the presence of social, personal, and financial support, and reflects how multiple negative stressors can be balanced by positive influences.

The IBOCS items were then further reified in the confirmatory factor analytic steps which showed that the proposed structure fit the data well. As an additional study to ensure that unnecessary or redundant items were not included in the final group, both sets of data were subjected to machine learning (ML) analyses to reduce the number of items to be considered. These analyses helped confirm that the 16 item IBOCS included only those items necessary to assess for levels of burnout and further to explore the contributions to individual variation.

In addition to the study of burnout items, we were interested in pathways and contributors to the experience of burnout. Focusing on the two contributor factors that emerged from the EFA, CFA, and ML analyses, Negative Contributors and Positive Contributors, our data reveal that individuals report that all the major areas of life can contribute to the experience of burnout, not just work-related stress. High scores on the NEG factor, an accumulation of the five types of life stress, correlate with higher scores on the PSS1 and the VIBE-10, demonstrating the cumulative impact of stress from all areas of life to the experience of burnout. Further, high scores on NEG negatively correlate with the PSS2 coping factor and the sense of wellbeing as measured by the SWEMWBS. The POS factor scores follow the opposite trend. Positive contributors, as identified by research in positive psychology, such as having positive social interactions, enjoying social support, and having resources to allow the pursuit of leisure time activities, directly correlate with coping skills PSS2 and wellbeing (SWEMWBS) and inversely correlate with PSS1 and VIBE-10. In sum, the EFA, CFA, and ML investigations into the psychometric properties and convergent delivery support that this new measure of burnout and contributors to burnout correlates well with measures of stress, (PSS 1 and VIBE-10), coping factors (PSS2) and wellbeing (SWEMWBS).

Latent class analyses were also performed in this study, with a five-class solution found to fit the data best across the continuums of EX and FX scores. The pattern of results suggests two main conclusions. First, burnout is more of a continuum than a binary entity as suggested by the multiple groups with slightly increasing levels of EX along with slightly decreasing levels of FX. As depicted in Figure 1, the lines representing the 5 classes in their levels of the 3 domains of the exhausted factor run nearly parallel to each other, reflecting the phenomenon that, for example, one's sense of feeling emotionally exhausted is closely tied to one sense of feeling physically tired. This pattern suggests that the 3 domains of the exhaustion pattern reflect a single unity construct that is dimensional in nature. While the latent class procedure forces individuals into categorical types with very low, low, moderate, high and very high levels of the EX-factor, these categories are likely more of an artifact from trying to group something that is more dimensional in nature. In personality trait research, where similar structures have been observed, this has been referred to as the "salsa" pattern, analogous to the way in which the continuum of spiciness

is somewhat arbitrarily fit into categories of mild, medium, and hot [44]. The other factor, fulfilled, revealed a very similar pattern except in reverse with classes that expressed higher levels of EX reporting lower levels of FX, and vice versa. The one exception to this pattern was LC4 to be discussed in more detail shortly.

A similar conclusion is reached when examining the results from the contributor items, namely that people who feel burnout from one area of their life are likely to perceive burnout from another. This finding was somewhat unexpected, as we would have predicted small classes whose burnout was driven primarily by one independent area of life (for example, health worries) and not others. Our inability to identify these groups suggests the possibility that burnout can result in a kind of “chain reaction” from one domain of life to another. Alternatively, the pattern could reflect more of consistent style in which someone perceives the inevitable stressors coming from all areas of one’s life relative to their threshold to cope with them.

Scrutinizing these classes more closely, the specific group of individuals with low EX scores and high FX scores (LC1) reveals a population of individuals who are relatively free of stress live with high levels of feeling fulfilled, valued, and accomplished. The fact that nearly 8% of informants fit this profile provides evidence that this aspirational space is attainable, but with the other 92% leading lives with at least slightly higher levels of EX and lower levels of FX.

The goal of identifying classes with intermediate scores was also realized, with LC2, consisting of nearly 15% of respondents, reporting slightly higher levels of EX and only slightly lower levels of FX. This group experiences stress and is engaged and fulfilled. The combined population prevalence of 23% of individuals existing in LC1 and LC2, in the face of a pandemic, is in fact quite remarkable and hopeful. The remaining three classes have different EX/FX architecture that also provide a lens of our modern world. LC3, 43% of the study population, report moderately high levels of EX and moderately high levels of FX. In fact, visual interrogation of Figure 1 appears to paint a portrait of a stressful life with high levels of engagement, accomplishment, and fulfillment. Given that LC3 is the largest of the classes, and given the stressors of modern life, it is not hard to predict that LC3 reflects a common dance that humans face to balance stress and fulfillment in their lives. LC4 (19%) and LC5 (16%) provide very different profiles. Where both classes reflect high scores on the exhaustion items, LC4 provides an interesting portrait. Stress is everywhere, and in fact many of us seek out, or invite stress into our lives, whether it be the pursuit of high-powered positions, engagement in competitive performance, athletics, etc. or taking on highly demanding social projects and policies. Clearly there are many very healthy, centered, and present individuals who lead these kinds of lives. LC4 reflects a group of almost 16% of our sample that have the highest exhaustion scores, but also very high fulfillment scores on feeling engaged, valued, and fulfilled. LC5 paints a different picture, as this group displays high EX scores, yet lower scores on the engaged, valued, and fulfilled items. A major focus of our ongoing work with the IBOCS will be to investigate the relations between this class and measures of emotional wellbeing, as most would agree that living a highly stressful life without feeling valued or engaged would be a tough life to live. Unfortunately, 16% of our sample find themselves in this spot. By comparing LC4 and LC5, a subtle but important lesson

emerges it is possible to live in highly stressful environments and still feel fulfilled and valued. An important future component of our work will be to compare other characteristics such as impairment, emotional behavioral health, demographic factors, sex, and financial characteristics between different LCs. In the same way that comparisons of LC4 and LC5 may help us learn about how best to balance the stress in our lives, comparisons between LC1, low EX and high FX, and LC4 high EX and High FX offer us a chance to better understand the roads to fulfillment in high stress versus low stress environments.

The LC of the 10 Contributor items and two dimensions (NEG and POS) provide evidence that burnout originates from multiple domains. In fact, in none of the 6 latent classes was work/school related stress the primary or only contributor to burnout. A review of the different profiles reveals important findings. LC1 represents 12.5% of the individuals in our study. These report very low levels of NEG Contributors and very high levels of POS contributors. This class, reminiscent of LC1 from the burnout item analyses, lives in a relatively stress-free space buttressed by high levels of social support, positive social interactions, and resources to support their social pursuits. We plan to pursue future research to determine additional characteristics of this fortunate group. LC2 (24.4%), LC3 (24.4%), LC4 (22.3%), represent 71% of the sample with increasing levels of NEG and POS contributors reported by each. This large sample of engaged, socially supported and active individuals, experience varying degrees of negative stress contributors balanced against varying degrees of positive factors. The remaining two classes, LC5 (24.4%) and LC6 (4.2%) provide us with very different profiles of understanding the relations between NEG and POS contributors to burnout. LC5 demonstrates sawtooth profile in which the most powerful contributors are work and health concerns. Unfortunately, this group also has the lowest positive support factors and suggests a large group of individuals who are struggling both professionally, and with their health. However, LC6, a much smaller group, provides a different profile. This group, which is somewhat similar to the LC5 for the burnout analyses, reports the highest levels of NEG stress contributors as well as the highest levels of POS social factors. Viewing stress and burnout through this lens brings us back again to the appreciation that for some individuals, living highly stressful lives and having highly rewarding social lives at the same time is attainable.

In sum, our LC work on both the burnout items and contributor items support our hypothesis that individuals can be categorized in a variety of stress and stress coping states. Further, both LCAs show evidence that it is possible to live in low stress high reward environments as well as high stress high reward environments, even if vast majority of us live somewhere in between where there is a delicate balance between our stress contributors, stress symptoms, social supports and our feelings of accomplishment and being valued.

Ultimately, the main purpose of this work was to build and test the IBOCS to move forward with future investigations that consider stress and its mediating and moderating factors such as sex, age, and socioeconomic status. In addition, factors such as emotional behavioral health, general medical health, social justice issues, gender identity, and long-term health issues, are all factors of concern that need to be explored in greater depth. We aim to do this work using modern digital data collection devices and then team these data to examine the relations between stress response patterns, coping strategies, and

stress-based personality types. Further, we aim to partner the IBOCS in studies with psychophysiological biomarkers of stress and stress responsivity such as heart rate, heart rate variability, blood oxygen levels, respiratory rate, actigraphy, and electrodermal activity using wearable technologies. Combining data from these sources, our goal is to create a one-of-a-kind digital health application that combines data on psychophysiology with measures of stress and burnout to provide individually tailored artificial intelligence-informed health coaching to implement strategies from health promotion, illness prevention, and positive psychology. With additional advances, we envision a time in which the measurement of stress and burnout will lead to the generation of real time insights, designed to aid the user to better manage their stress and change the arc of their wellbeing. Toward these goals, the IBOCS is a promising new scale to measure burnout and contributors to burnout, particularly regarding the experience and response to multifactorial sources of stress.

Abbreviations

Abbreviation	Meaning	Page
IBOCS	Individual Burnout and Contributors Scale	6
IRB	Institutional Review Board	8
PSS	Perceived Stress Scale	8
SWEMWBS	Short Warwick Edinburgh Mental Well-Being Scale	9
VIBE	Virtual Inventory of Behaviors and Emotions	9
EFA	Exploratory Factor Analyses	9
CFA	Confirmatory Factor Analyses	10
RFE	Recursive Feature Elimination	10
LCA	Latent Class Analyses	11
BIC	Bayesian Information Criterion	11
BO1	Burnout Dimension 1	12
EX	Exhaustion Dimension	12
FX	Fulfilled Dimension	12
NEG	Negative Dimension	13
POS	Positive Dimension	13
ML	Machine learning	19

Declarations

Conflict of Interest Statement: All the authors are either employees or consultants to Happy Health, Inc. Dr. Hudziak is also a consultant to Health Productivity Solutions. Dr. Rettew receives royalties from Oxford University Press and Psychology Today.

Data Accessibility statement: Data from this study are not available due to the raw data being important intellectual property for Happy Health, Inc.

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Tables

Table 1. Original Burnout Items

Over the past week, how often have I felt...	Never	Rarely	Sometimes	Often	Always
1. That your life has purpose and meaning	1	2	3	4	5
2. Emotionally exhausted	1	2	3	4	5
3. Physically tired and worn out	1	2	3	4	5
4. That you have a healthy life balance	1	2	3	4	5
5. Burned out	1	2	3	4	5
6. More negative towards the people and events around you	1	2	3	4	5
7. Engaged and accomplished in what you're doing	1	2	3	4	5
8. Valued as a person	1	2	3	4	5
9. Fulfilled in your daily life	1	2	3	4	5

Table 2. Original Burnout Contributor Items

Over the past week, how often have I felt...					
	Never	Rarely	Sometimes	Often	Always
1. That you should cut down on your phone usage	1	2	3	4	5
2. Judged or sad when you spend time on your phone	1	2	3	4	5
3. Worried about your health	1	2	3	4	5
4. Like your physical and/or emotional health is worse than it should be	1	2	3	4	5
5. That you have had enough social support	1	2	3	4	5
6. That you have generally had positive social interactions	1	2	3	4	5
7. That relationship worries could be causing you to spend too much time on your phone or use substances	1	2	3	4	5
8. Less interested or enthusiastic about your work / school than usual	1	2	3	4	5
9. That your work / school demands are too much for me	1	2	3	4	5
10. That work / school worries could be causing you to spend too much time on my phone or use substances	1	2	3	4	5
11. That you have enough money for the necessities - home, food, healthcare, transportation, etc.	1	2	3	4	5
13. That financial worries could be causing you to spend too much time on your phone or use substances	1	2	3	4	5
14. Burnout could be causing you to spend too much time on my phone or use substances	1	2	3	4	5
	1	2	3	4	5

Table 3. Final Burnout Survey Items

Over the past week, how often have I felt...					
	Never	Rarely	Sometimes	Often	Always
1. Emotionally exhausted	1	2	3	4	5
2. Physically tired and worn out	1	2	3	4	5
3. More negative towards the people and events around you	1	2	3	4	5
4. Engaged and accomplished in what you're doing	1	2	3	4	5
5. Valued as a person	1	2	3	4	5
6. Fulfilled in your daily life	1	2	3	4	5

Table 4. Final Burnout Contributor Survey Items

Over the past week, how often have I felt...					
	Never	Rarely	Sometimes	Often	Always
1. That you should cut down on your phone usage	1	2	3	4	5
2. Judged or sad when you spend time on your phone	1	2	3	4	5
3. Worried about your health	1	2	3	4	5
4. Like your physical and/or emotional health is worse than it should be	1	2	3	4	5
5. That you have had enough social support	1	2	3	4	5
6. That you have generally had positive social interactions	1	2	3	4	5
7. Less interested or enthusiastic about your work / school than usual	1	2	3	4	5
8. That your work / school demands are too much for you	1	2	3	4	5
9. That you have enough money to afford the kind of fun and leisures that you would like	1	2	3	4	5
10. That financial worries could be causing you to spend too much time on your phone or use substances	1	2	3	4	5

Table 5. Demographic Information

Total

N=1244

N (%)

Age Group	
12-17	94 (7.6%)
18-24	254 (20.4%)
25-34	440 (25.4%)
35-49	317 (25.5%)
50 and above	139 (11.2%)
Sex	
Female	673 (54.1%)
Male	565 (45.4%)
No answer	6 (0.5%)
Gender	
Female	659 (53.0%)
Male	552 (44.4%)
Genderqueer	20 (1.6%)
Trans female	5 (0.4%)
Trans male	3 (0.2%)
Other	1 (0.1%)
No answer	4 (0.3%)
Country	
United States	1218 (97.9%)
Great Britain	4 (0.3%)
Canada	2 (0.2%)
India	2 (0.2%)
Other	18 (1.4%)
Education	
No HS Diploma	88 (7.1%)

HS Diploma/GED	232 (18.6%)
Some College	173 (13.9%)
Associate Degree	83 (6.7%)
Bachelor's Degree	415 (33.4%)
Some Graduate School	29 (2.3%)
Master's Degree	189 (15.2%)
Doctoral/Law Degree	18 (1.4%)
Other	7 (0.6%)
No Answer	10 (0.8%)
Race	
White	769 (61.8%)
Black AA	187 (15.0%)
Asian American	89 (7.2%)
Native American	12 (1.0%)
Pacific Islander	2 (0.2%)
Hispanix/Latinx	77 (6.2%)
Multi-Racial	94 (7.6%)
Other	5 (0.4%)
Don't know	2 (0.2%)
No answer	7 (0.6%)

Table 6. VIBE-10 Items

Indicate the extent to which the following statements apply to you:					
	Very Untrue	Somewhat Untrue	Neither True nor Untrue	Somewhat True	Very True
1. I worry often and a lot	1	2	3	4	5
2. I stress out easily	1	2	3	4	5
3. I have a lot of doubts about my ability to be successful	1	2	3	4	5
4. I have a tough time shaking off negative comments or interactions	1	2	3	4	5
5. I lose my cool	1	2	3	4	5
6. I almost constantly need to check my phone	1	2	3	4	5
7. I get less sleep than others	1	2	3	4	5
8. I'm able to deal with my stress	1	2	3	4	5
9. Currently, it feels like I just can't keep up with all of the demands on me	1	2	3	4	5
10. I've been upset lately over unanticipated events in my life	1	2	3	4	5

Table 7. Burnout 6 and Burnout 10 Correlation Table

		PSS Factor 1	PSS Factor 2	PSS	SWEMWBS	VIBE-10
Burnout-6	Exhausted (Factor 1)	0.72	-0.25	0.67	-0.56	0.73
	Fulfilled (Factor 2)	-0.28	0.63	-0.50	0.67	-0.35
Burnout-10	Negative (Factor 1)	0.74	-0.11	0.61	-0.50	0.71
	Positive (Factor 2)	-0.18	0.58	-0.41	0.56	-0.25

Table 8. Burnout 6 Factor-Loading Table

		Factor 1 Loading	Factor 2 Loading
Exhausted (Factor 1)	Emotionally exhausted	0.84	-0.13
	Physically tired	0.70	-0.10
	More negative	0.57	-0.17
Fulfilled (Factor 2)	Engaged and accomplished	-0.13	0.66
	Valued	-0.16	0.72
	Fulfilled	-0.18	0.80

Table 9. Burnout 10 Factor-Loading Table

		Factor 1 Loading	Factor 2 Loading
Negative (Factor 1)	Less enthusiastic about work/school	0.74	-0.12
	Spend time on phone	0.72	0.12
	Work/school demands	0.69	-0.08
	Financial worries	0.68	0.05
	Physical/emotional health	0.64	-0.18
	Phone usage	0.61	0.13
	Worries about health	0.59	-0.09
Positive (Factor 2)	Social support	0.02	0.75
	Social interactions	-0.05	0.68
	Money for necessities	-0.03	0.45

Table 10. Perceived Stress Scale Factor-Loading Table

		Factor 1 Loading	Factor 2 Loading
PSS Factor 1	Upset because of something unexpected	0.77	-0.12
	Unable to control important things in life	0.75	-0.21
	Felt nervous and stress	0.75	-0.19
	Not able to cope with things	0.71	-0.16
	Angered because of things out of control	0.70	-0.10
	Difficulties piling up high	0.77	-0.21
PSS Factor 2	Confident in ability to handle problems	-0.14	0.67
	Felt things were going your way	-0.13	0.71
	Able to control irritations	-0.10	0.64
	On top of things	-0.16	0.73

Figures

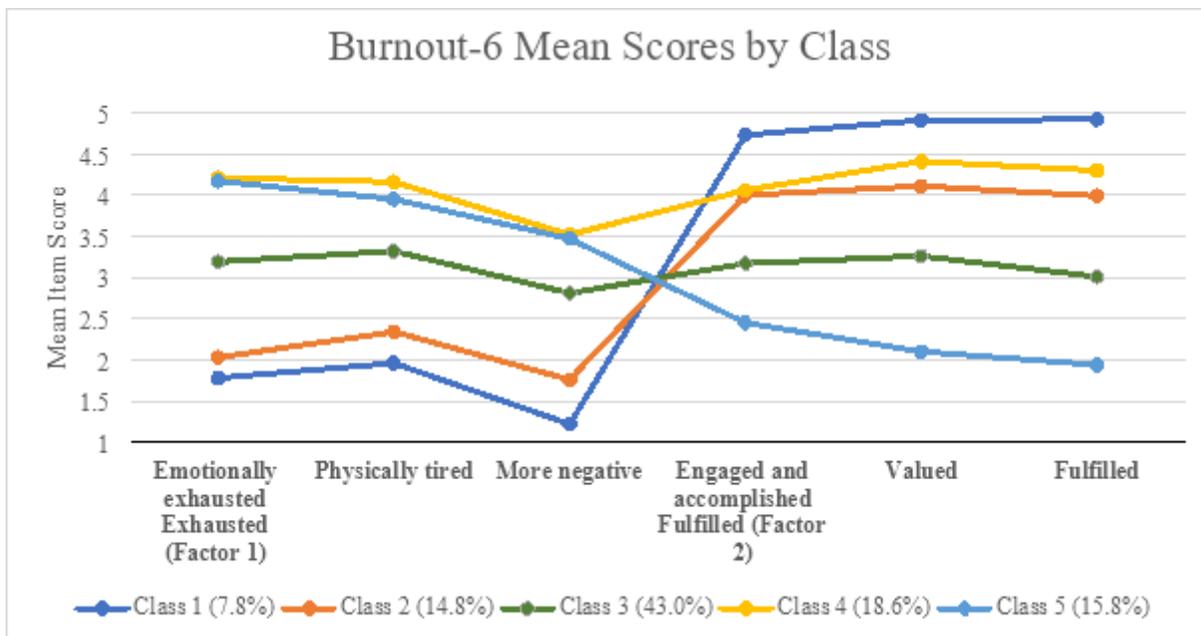


Figure 1

Burnout 6 Item Means by Class

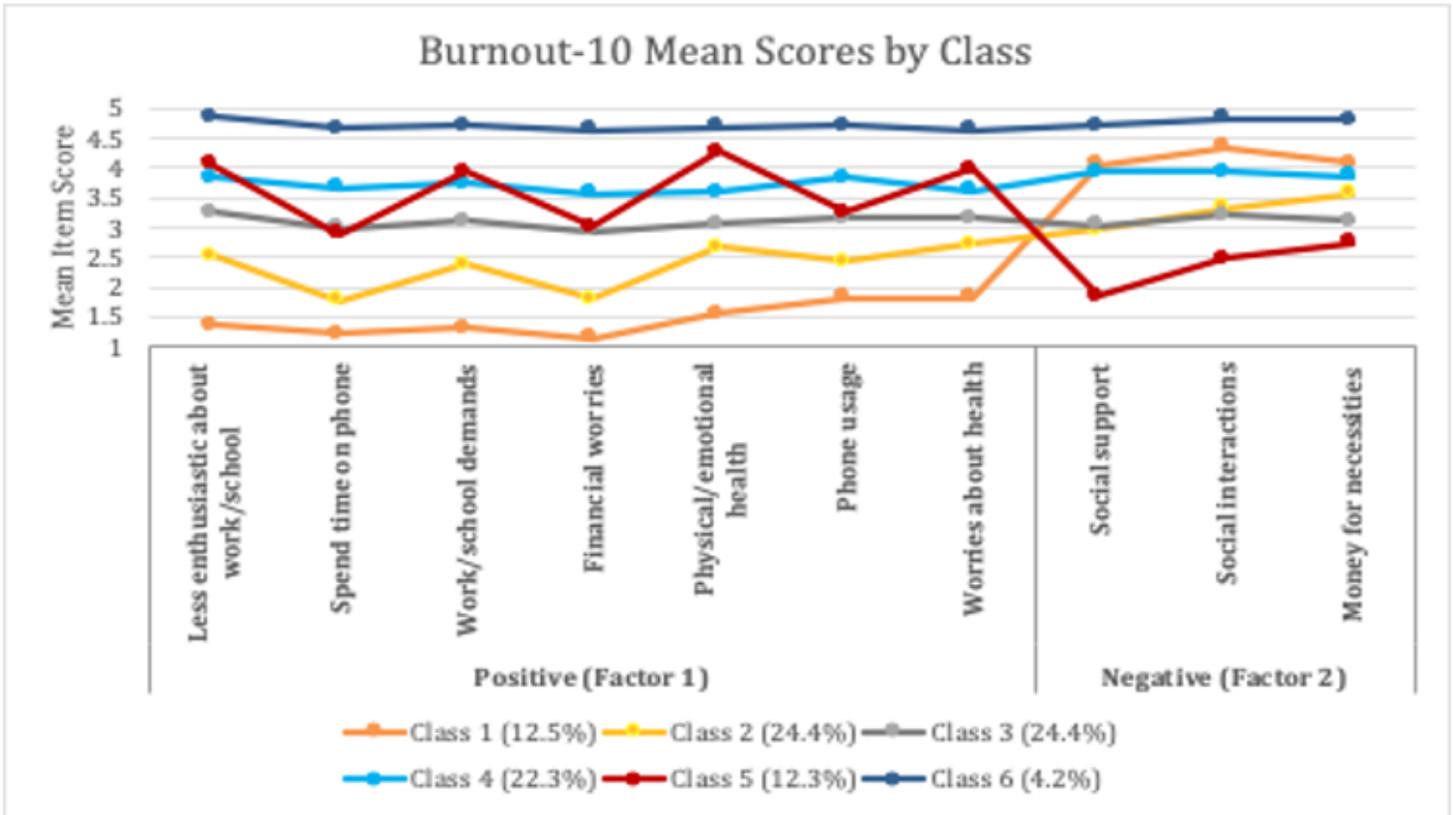


Figure 2

Burnout 10 Item Means by Class

Ranking Burnout VS Question

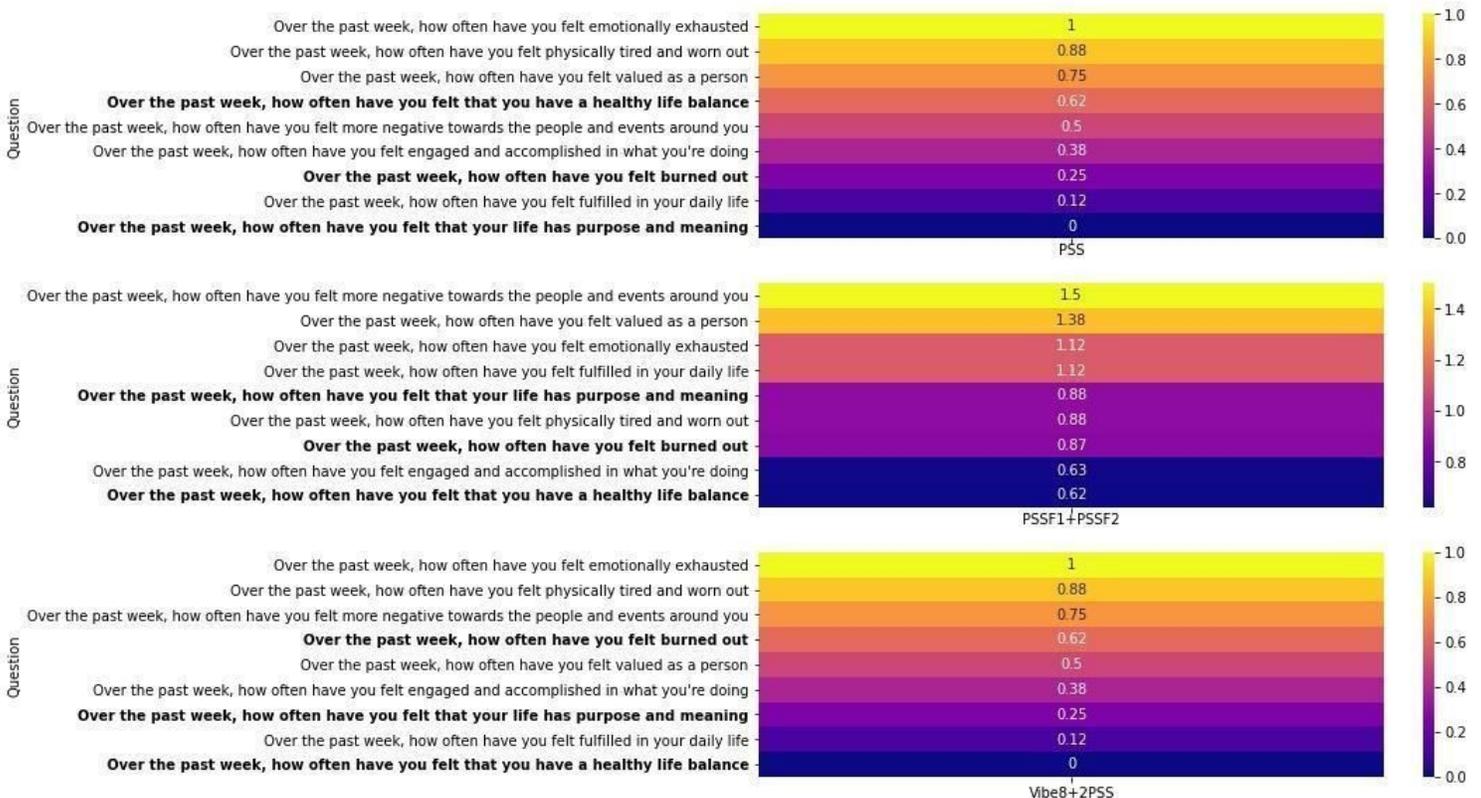


Figure 3

Ranking scores of the Burnout Questions **The three subplots show the results for different reference sets. The three removed questions are indicated in bold.

Ranking Contributors VS Question



Figure 4

Ranking Scores of the Stress Contributor Questions **The three subplots show the results for different reference sets. The three removed questions are indicated in bold.