[Monni, A. & Scalas, L.F., Health Risk Behavior Inventory and its association with different self-regulatory dispositions, Journal of Clinical Psychology in Medical Settings, 29(4), 2022, 861-874]

The publisher's version is available at:

http://dx.doi.org/10.1007/s10880-022-09854-z

Health Risk Behavior Inventory and its association with different self-regulatory dispositions

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Abstract

Objective: We put forward a validation of the first instrument to measure the big four health risk behaviours (WHO, 2014) in a single assessment, the Health Risk Behaviour Inventory (HRBI) that assesses physical inactivity, unhealthy diet, smoking and alcohol in an Italian- and English-speaking sample. Further, we investigate the instrument's association with self-regulatory dispositions, exploring culture and gender differences in an Italian and US subgroup samples.

Methods: Overall, 304 English- and 939 Italian-speaking participants completed the HRBI and the self-regulatory questionnaire. We explored the factorial structure, convergent validity, invariance and association with self-regulatory dispositions using structural equation modelling.

Results: The HRBI has a robust factorial structure; it usefully converges with widely used healthy lifestyle measures, and it is invariant across the categories of age, gender and languages. Regarding self-regulatory dispositions, the promotion focus emerges as the most protective factor over physical inactivity, unhealthy diet, smoking and alcohol, whereas the prevention focus is associated mainly with smoking and alcohol reduction. Results are consistent across genders and US subgroup-Italian samples.

Conclusions: The HRBI is a valid instrument for assessing the big four health risk behaviours in clinic and research contexts, and among self-regulatory measures, the promotion and prevention foci have the greatest efficacy in eliciting positive health behaviours.

Key Words: health risk behavior; approach-avoidance; promotion-prevention focus; cross-cultural difference; gender difference

Health Risk Behavior Inventory and its association with different self-regulatory dispositions

Introduction

The World Health Organization (WHO) has indicated that physical inactivity, unhealthy diet, cigarette smoking and alcohol consumption are the big four health risk behaviours that are alone responsible for more than two-thirds of chronic diseases (WHO, 2014) and compromise either physical (Forouzanfar et al., 2013; Ng et al., 2020) or mental health (Hiles et al., 2015; Jao et al., 2019). Assessing health risk behaviours is a major paradigm of enquiry in the research and clinical fields, but the majority of instruments usually measure only one health risk behaviour at a time. The response options, metrics and time frames to explore these behaviours differ substantially across various questionnaires, often within the same questionnaire. Furthermore, some instruments have been designed to assess heavy risk behaviours but are inappropriate to measure non-problematic behaviours over a comprehensive range (e.g. AUDIT, Babor & Grant, 1989; Fagerström Test for Nicotine Dependence (FTND), Heatherton et al., 1991).

Thus far, very few instruments have explored multiple health risk behaviours through a single standardised assessment (Babor et al., 2004), and to our knowledge, only four are available and salient for the adult population. The Health Promoting Lifestyle Profile (Walker et al., 1987) measures only exercise, nutrition, sleep/stress management and health-promoting perceptions (self-actualisation, personal responsibility and interpersonal support) and excludes alcohol and smoking assessment; the Healthy Lifestyle Screening Tool (Kim & Kang, 2019) assesses sunlight exposure, water consumption, air or ventilation, rest, exercise, nutrition, temperance, trust and physical condition but explores alcohol and smoking with only one question 'I do not drink alcohol or smoke'. Instead of these self-reporting instruments, some researchers developed an extensive telephone survey, the Behavioural Risk Factor Surveillance System (BRFSS) (Pierannunzi et al., 2013), which explores a wide variety of risk behaviours but is problematic to use. Finally, Glasgow and colleagues (2005) developed an instrument derived from a combination of 22 questions extracted from six validated instruments assessing the big four risk behaviours (physical activity using the International Physical Activity Questionnaire (IPAQ), Craig et al., 2003; eating patterns using the Starting the Conversation, Paxton et al., 2007; cigarette smoking using the Centers for Disease Control and Prevention (CDC) paradigm, 2003, Hughes et al., 2003; Ory et al., 2002; and alcohol use using the BRFSS, Pierannunzi et al., 2013; CDC, 2003); nonetheless, this instrument is inconsistent with respect to time frame and response options, making it difficult for researchers to compare the different subscales and for respondents to answer the questions, since the response format changes from item to item.

To the best of our knowledge, the only attempt to provide a measure of the big four health behaviours refers to the Health Risk Behaviour Inventory (HRBI) developed in a doctoral dissertation (Irish, 2011). The first version of the HRBI is a self-reporting questionnaire that assesses, through 68 items in a 5-point Likert scale, physical inactivity, unhealthy diet, smoking, alcohol consumption, illicit drug use, sleep and risky sexual behaviours in the current month. After having developed the first pilot version, the author then revised the questionnaire format moving away from the Likert scale to multiple-choice responses and validated the latter version in the resultant doctoral thesis, but later has not finalised the validation process in a published peer-reviewed journal. We believe that this instrument has the potential of providing a measure of multiple health risk behaviours in a single assessment, which is otherwise missing in the current literature. To fulfil this aim, the version of the instrument based on a Likert scale, is preferable due to the opportunity to rate each statement through a consistent metric. Thus, the purpose of the present study was to refine and implement the HRBI validation.

Some authors underline the importance of having culture-neutral instruments in assessing health risk behaviours (Kim & Kang, 2019), and researchers encourage future studies to explore the cultural framework in lifestyle risk behaviours (King et al., 2015; Singer et al., 2016). Moreover, many studies evidenced gender differences in health risk behaviours (Olfert et al., 2019; Patró-Hernández et al., 2019; Ryu et al., 2020; Westmaas et al., 2002) and argued that gender shapes the adoption of health behaviours and should be considered a determinant of health (Hwang et al., 2019; Liang et al., 2003). Finally, an epidemiological study, including participants from Western and non-Western countries, evidenced different patterns with respect to age in health-risk-taking (Duell et al., 2018); thus, the assessment of health risk behaviour should take culture, age and gender into account.

Self-regulatory dispositions and health behaviours

A critical need in health psychology is to identify the psychological determinants of health behaviours (Jeffery et al., 2000). Friese and colleagues have included two self-regulatory dispositions as salient variables with respect to a risky lifestyle; these are the tendency to push towards positive stimuli and the tendency to run away from potential threats (Friese et al., 2011). However, studies that systematically investigate the association between the big four health behaviours and self-regulatory dispositions, through the various constructs employed in the literature to operationalise them, are missing from the extant literature (Monni et al., 2020). For the present investigation, we consider Elliot's approach-avoidance temperaments model and Higgins's promotion and prevention foci model. In particular, Elliot's approach temperament measures the individual's predisposition to be extroverted, emotionally positive and more sensitive to rewarding stimuli, whereas the avoidance temperament measures the individual's predisposition to be neurotic, emotionally negative and more acutely sensitive to punishment stimuli (Elliot & Thrash, 2010). Higgins's promotion focus measures the tendency to be proactive and liable to attempt to obtain the maximum goal, whereas the prevention focus measures the tendency to be somewhat cautious, guided by a sense of duty and the avoidance of negative consequences (Higgins, 1997). Regarding Elliot's temperaments theory, we found only one study exploring approach-avoidance temperaments and health risk behaviours; in this study, Dalley (2006) found that the avoidance temperament is associated with a weight loss diet. Several studies examined the relationship between Higgins's promotion and prevention foci theory (Higgins, 1997) and attendant health risk behaviours. A high prevention focus is associated with more physical activity in individuals with stress burnout (Liang et al., 2013) and a lower probability of relapsing with respect to either smoking (Fuglestad et al., 2013, 2008) or weight loss (Fuglestad et al., 2008), but it is also associated with increased calorie consumption and giving up a diet (Testa & Brown, 2015). The high promotion focus is associated with more physical activity (Joireman et al., 2012; Milfont et al., 2017) and a healthy diet (Joireman et al., 2012) and predicts success in quitting smoking and achieving weight loss

(Fuglestad et al., 2008), successfully recovering to again quit smoking after a relapse (Fuglestad et al., 2013) and long-term maintenance of weight loss (Fuglestad et al., 2015). To our knowledge, no current study has investigated the association between self-regulatory dispositions and alcohol consumption. Furthermore, the big four risk behaviours have never been systematically analysed regarding different self-regulatory dispositions within a single investigation, given that most studies only analysed one or two risk behaviours at a time. Due to these inconsistent and incomplete results, further research would appear to be needed.

To fill this gap, we aimed to study possible differences across culture, age and gender in the association between different self-regulatory dispositions and the big four risk behaviours. Only one study found that gender did not differentiate in the association between the high approach trait and more physical activity (Gallagher et al., 2012). However, the authors assessed self-regulatory dispositions through a single question and analysed physical activity only. Although a healthy lifestyle is impacted by different motivations across cultures (Hawks et al., 2003), to the best of our knowledge, no previous study has explored these differences in the association between self-regulatory dispositions and health behaviours. In addition, none analysed age difference effects. Thus, a deeper analysis of self-regulatory dispositions and a wider range of health behaviours is needed to better understand this topic.

The present study

To achieve these purposes, our first aim is to contribute to the validation of the HRBI, focusing on the big four problematic lifestyles according to the WHO, refining the questionnaire and analysing the factorial structure in an Italian- and English-speaking sample. We also explore HRBI's convergent validity with well-validated health measures and address the invariance of the factorial structure across age, gender and Italian- English versions.

Our second aim is to explore the association between self-regulatory dispositions and health risk behaviours and investigate the cross-cultural, age and gender differences in this association by comparing the Italian and US subgroup samples.

Method

Participants and procedures

The HRBI questionnaire was administered in different samples and was part of a battery of instruments as described in Table 1. Only Sample 1 completed the HRBI in the classroom at the end of a lesson. The other samples were recruited through internet ads on Facebook groups: university departments groups, workers groups, hobby groups and survey exchange groups. Interested participants completed the questionnaires protocol through a Google Forms worksheet online from August 2019 to February 2020. They provided informed consent before completing the actual questionnaire, and anonymity was guaranteed. We excluded five participants who did not answer the questions on demographic data (ethnicity, city and state where you live, occupation). The study was approved by the Ethics Committees of La Sapienza University of Rome and University of Cagliari.

[Table 1 near here]

Measures

The HRBI (HRBI pilot version; Irish, 2011), as mentioned above, investigates seven risky behaviours. In our work, we selected the big four risk behaviours producing a 40-item questionnaire, and then we shortened and refined the instrument through structural equation modelling (SEM). Details of the procedure are described in the Results section. The refined version is composed of 21 items, 5 items for physical activity, four items for an unhealthy diet, six items for alcohol consumption and six items for smoking. Responders are requested to indicate the extent to which the statements are true of their behaviour over the past month using a 5-point Likert scale (from 1=Never true to 5= Always true). For the Italian version, the HRBI questionnaire was translated into Italian by three independent translators, and the final version was back-translated into English by an expert. We calculated the internal reliability of the HRBI through McDonald's ω index (McDonald, 1970). The omegas for the English version are HRBI physical activity =.86, HRBI unhealthy diet =.72, HRBI smoking =.93 and HRBI alcohol=.94. The omegas for the Italian version are HRBI physical activity =.88, HRBI unhealthy diet =.71, HRBI smoking =.95 and HRBI alcohol=.91.

The IPAQ short form (Booth, 2000) is composed of seven open questions on moderate–intense physical activity, walking and sedentary time expended in the last week, where higher scores indicate more physical activity. The reliability and validity of the IPAQ short form have been confirmed in 12 countries and for different languages (http://www.ipaq.ki.se/ipaq.htm), and it has been validated in Italian (Mannocci et al., 2010). Cronbach's alpha for the English version is.66. Cronbach's alpha for the Italian version is.62 (in line with the Italian validation paper =.67, Mannocci et al., 2010).

The Food Habits Questionnaire (Turconi et al., 2003) is composed of 14 items; 8 items' responses were designed in a 4-point Likert scale (always, often, sometimes, never); the other six items were structured in four response categories that were different for each question. This instrument investigates the number of meals, daily consumption of vegetables and fruits, breakfast content and consumption of alcoholic and soft beverages. Higher scores indicate healthier food habits. Cronbach's alpha is.62 for the English version, and it is.67 for the Italian version.

The FTND (Fagerström & Schneider, 1989; Italian validation by Lugoboni et al., 2007) is a valid and reliable instrument and is largely used in the literature to measure nicotine dependence. The FTND is composed of six questions on the level of nicotine dependence. To include non-smoker participants, before administering the FTND, we added a preliminary question on smoking: 'You are' smoker, occasionally smoker (maximum of three cigarettes per month) and non-smoker. Only 'smoker' participants were requested to complete the FTND. Cronbach's alpha is.70 for the English version, and it is.98 for the Italian version.

The Alcohol Use Disorders Identification Test is a self-reporting questionnaire on drinking problems and has been developed by the WHO as a Collaborative Project on the early detection of persons with harmful alcohol consumption (Saunders et al., 1993). It is composed of 10 items that explore the amount and frequency of drinking, alcohol dependence and the problems associated with alcohol dependence, where a higher score indicates alcohol dependence. The instrument has been validated in Italian (Piccinelli et al., 1997). Cronbach's alpha for the English version is.89, and the Cronbach's alpha for the Italian version is.83.

The approach-avoidance temperament questionnaire (Elliot & Thrash, 2010; Italian version Monni & Scalas, 2020a) is a valid and reliable questionnaire composed of 12 items with a 7-point Likert scale and investigates the approach (e.g. 'I am always on the lookout for positive opportunities and experiences') and the avoidance temperament (e.g. 'When it looks as if something bad could happen, I have a strong urge to escape'). The omegas for the English version are approach temperament =.84 and avoidance temperament =.87. The omegas for the Italian version are approach temperament =.84 and avoidance temperament =.86.

The Regulatory focus questionnaire (Higgins et al., 2001; Italian version Monni & Scalas, 2020b) is a valid and reliable questionnaire that is composed of 11 items with a 5-point Likert scale and measures the prevention focus (e.g. 'How often did you obey rule and regulations that were established by your parents'?) and the promotion focus (e.g. 'Do you often do well at different things that you try'?). The omegas for the English version are promotion focus =.72 and prevention focus =.85. The omegas for the Italian version are promotion focus =.77 and prevention focus =.76.

Data analysis

We employed SEM using Mplus software (version 8.1, Muthen & Muthen, 2017). Since some of the variables associated with risk behaviours such as smoking and drinking alcohol were non-normally distributed, we treated all the variables as non-normally ordered categorical data, and we used Weighted Least Squares Means and Variance as our estimation method (Brown, 2006). That is, instead of calculating the standard score (Z points) of item responses, we used raw ordinal values resulting from the Likert scale data. Researchers are recommended to employ this method given that values of the comparative fit index (CFI) might be underestimated when using standardised scores for non-normally distributed data (Finney & DiStefano, 2006; Urbán et al., 2014).

To assess the model's adequacy, we referred to the chi-square value (χ^2), CFI and the Tucker–Lewis Index (TLI) above .90 or. 95 as sufficient or satisfactory fit values and the Root Mean Square Error of Approximation (RMSEA) below .08 or .06 (Hu & Bentler, 1999). We explored the invariance across languages and genders, and to support the factorial invariance, the difference of CFI and RMSEA between the more and the less restrictive model were compared and they should not exceed a ΔCFI of .01 and a $\Delta RMSEA$ of .015 (Cheung & Rensvold, 2002).

Results

First, we calculated means, standard deviations, ranges, skewness and kurtosis for each subscale score. We found appropriate normality for physical inactivity and unhealthy diet, whereas smoking and alcohol consumption were positively skewed and had the lowest mean compared with other subscales for both Italian- and English-speaking respondents (Table 2). These results suggest reduced tobacco and alcohol use among our participants.

[Table 2 near here]

HRBI Pre-test. We performed an exploratory factor analysis (EFA) on the student sample. The four factors' structure EFA showed a good fit to the data, $\chi^2_{(626)}$ = 756.684, *p* <.05, *CFI* =.96, *TLI* =.95, *RMSEA* =.048, and four factors have been identified (Table 3). Only items with factor loadings higher than.500 were included in the HRBI. Furthermore, we excluded an item with a double statement (HRBI3).

After this procedure, from the original set of 40 items, we selected a set of 21 items divided into four factors: sedentary life (4 items), unhealthy diet (5 items)[1], smoking (6 items) and alcohol consumption (6 items). The selected items are indicated in bold in Table 3. The refined version of the HRBI was initially tested in Sample 1, a small Italian sample composed of university students (N=91). We found very good fit indices ($\chi^2_{(183)}$ = 202.602, *p* <.05, *CFI* =.99, *TLI* =.99, *RMSEA* =.034) and satisfactory factor loadings for all items ranging from .400 to .967. We reported a significant correlation only between smoking, an unhealthy diet (*r* = .292, *p* >.05) and alcohol (*r*= .509, *p* <.001) (Table 4).

[Table 3 near here]

Confirmatory factor analysis and invariance over the Italian- and English-language versions and over age and gender. The factor structure of the HRBI was then tested with the Italian- (Sample 2) and the English-speaking Sample (Sample 3) using confirmatory procedures (confirmatory factor analysis). We registered solid fit indices for both the Italian and the English version of the HRBI (English version $\chi^2_{(183)}$ = 465.512, *p* <.05, *CFI* =.99, *TLI* =.99, *RMSEA* =.043; Italian version $\chi^2_{(183)}$ = 465.512, *p* <.05, *CFI* =.99, *TLI* =.99, *RMSEA* =.050) and high factor loadings (Sample 2 range .506–.997; Sample 3 range.400–.966) (see Table 4). For both samples, we found a positive correlation between an unhealthy diet and physical inactivity, an unhealthy diet and smoking and smoking and alcohol consumption. Notably, enhanced alcohol consumption was correlated with unhealthy diet only in the Italian respondents' sample and with less physical inactivity in the English respondents' sample (Table 4).

We explored the invariance of the factorial structure across age, gender and the Italian- and English-language versions of the HRBI. Previous studies revealed group-level changes in identity status at the age of 25 (Eriksson et al., 2020); thus, we transferred the 25-year-old participants to separate early and middle adulthood groups.

Given the uneven number of participants across the samples, using the 'Select cases' function in SPSS, we randomly selected an Italian sub-sample composed of an equal number of participants to the English-speaking sample (see Table 1 for the demographic composition of sub-sample 2). We observed that the factorial structure was invariant across age, gender and within the English- and Italian-speaking samples (Table 5).

[Tables 4 and 5 near here]

Convergent validity with well-validated risk behaviour questionnaires. We explored the convergent validity between HRBI and the health behaviour questionnaires described above. We tested a latent model with eight correlated latent factors: four factors of the HRBI (HRBIpi, HRBIud, HRBIs, HRBIa) and the four questionnaires' total scores (the IPAQ, the food habit questionnaire, the Fagerström test and the AUDIT). The models showed a good fit to the data for both the Italian ($\chi^2_{(251)}$ = 596.642, p <.05, *CFI* =.99, *TLI* =.99, *RMSEA* =.047) and the English-speaking sample ($\chi^2_{(251)}$ = 422.658, p <.05, *CFI* =.97, *TLI* =.97, *RMSEA* =.047) and satisfactory factor loadings (>.400). The correlation matrix between HRBI and other health behaviour measures can be seen in Table 6. For the Italian sample (Sample 2) and the English-speaking sample (Sample 3), we reported that high scores on Fagerström (nicotine use) and AUDIT (alcohol consumption) questionnaires strongly correlated with the attendant high HRBI smoking and alcohol scores; high scores on the HRBI for unhealthy diet were negatively associated with healthy food habits measured with FHAB, and the HRBI physical inactivity was negatively related with IPAQT physical activity, especially for the English-speaking sample (Sample 3).

[Table 6 near here]

The association between health risk behaviours and self-regulatory dispositions considering the effects of age, gender and culture. As an initial step, we calculated the invariance over age, gender and culture of the general measurement model, and the results are as reported in Table 7. This step is mandatory when researchers are interested in analysing the SEM in different groups. For cultural differences, we selected a subgroup composed only by US participants, and we compared this sample with the Italian Sample 6a (Sample 7). The factorial structure was invariant across the US subgroup vs Italian samples for configural and metric invariance (ΔCFI <.01; $\Delta RMSEA$ <.015), whereas we did not observe scalar invariance (ΔCFI =.016). Two items appear to account for this difference: HRB17 ‘I ate breakfast every day’ and ATQ9 ‘When it looks as if something bad could happen, I have a strong urge to escape’. Calculating partial scalar invariance and subsequent levels of invariance, we reported no difference between the US subgroup and Italian samples (Table 7). Regarding gender, we only evidenced a difference of means level invariance (ΔCFI =.02 with Variance–Covariance level) (Table 7); thus, males and females showed different factor means; in particular, females reported enhanced HRBI physical inactivity and avoidance temperament and reduced HRBI alcohol consumption compared to the male group. We did not register any difference between the early (<25) and middle (>25) adulthood groups. According to Vandenberg and Lance (2000) when the groups are found to be invariant at the Variance–Covariance level of invariance (i.e. ΔCFI <.01 and $\Delta RMSEA$ <.015 between the Variance–Covariance level and residual Variance level), it can be concluded that the betas in an SEM model are invariant across groups. In light of this, we could state that the US subgroup and Italian samples, early-middle adulthood participants and male–female would show the same association between self-regulatory dispositions and health risk behaviours.

[Table 7 near here]

Therefore, we calculated an SEM model on the aggregated US subgroup and Italian samples (Sample 7) in which self-regulatory dispositions would predict health risk behaviours. The model showed an acceptable fit to the data $\chi^2_{(874)} = 1809.220$, p <.05, CFI =.935, TLI =.930, $RMSEA$ =.046. Results showed that individuals with a high promotion focus are less prone to have a sedentary life, follow an unhealthy diet or smoke or drink alcohol, whereas individuals with a high prevention focus are less prone only to smoke or drink alcohol but more prone to physical inactivity. In line with results for the prevention focus, an avoidance temperament protects from smoking, whereas an approach temperament does not appear to influence any risk behaviour (Table 7).

Discussion

Assessing health risk behaviours has important relevance in clinical and research contexts. The aim of the current study was twofold: first, to provide the first validation of the HRBI in a sample of Italian- and English-speaking respondents, analysing the factorial structure, the convergent validity and the invariance across age, gender and the English-Italian versions-; second, to investigate the association between self-regulatory dispositions and health risk behaviours exploring cross-cultural, age and gender differences in the Italian and the US subgroup sample.

We observed that the HRBI has a robust factorial structure and is invariant across age, gender and the Italian–English-speaking samples. We highlighted the convergent validity of the specific HRBI scales with commonly used healthy lifestyle assessments, particularly with Fagerström (nicotine use), AUDIT (alcohol consumption) and FHAB (healthy food habits) tests that showed high correlations, whereas only a medium correlation was found with IPAQT (physical activity).

From the SEM analysis, it emerged that individuals with a high promotion focus are less prone to have a sedentary life, follow an unhealthy diet or smoke or drink alcohol. Individuals with high prevention focus or avoidance temperament showed less smoking or alcohol use, but a high prevention focus also induces a sedentary life. Our results confirmed the evidence of a positive association between a promotion focus and physical activity (Milfont et al., 2017; Joireman et al., 2012) and a healthy diet (Joireman et al., 2012). Moreover, the effect of a promotion focus on smoking and a healthy diet is in line with Fuglestad and colleagues' results in which promotion focus has a positive effect on weight loss and quitting smoking (Fuglestad et al., 2015, 2013, 2008) and a prevention focus has a positive effect on refraining from smoking (Fuglestad et al., 2013, 2008). Conversely, we did not replicate the results of Testa and Brown (2015) showing an association between an unhealthy diet and a prevention focus, which in our sample appear to be unrelated. In addition, whereas Liang and colleagues recorded an association between a prevention focus and more physical activity (Liang et al., 2003), we found the opposite effect. However, they found this association among 'stressed' participants, whereas in our study, we did not control for the effect of stress. In addition, we did not replicate Dalley's findings (2016) in which an avoidance temperament was associated with a weight loss diet. For the first time, we reported results on promotion and prevention focus and alcohol.

Regarding our second aim, we explored age, gender and cultural differences. Confirming Gallagher and colleagues' results (2012), we found an association between an approach motivation and enhanced physical activity that was similar across gender, and we specified that the enhanced physical activity is associated with a promotion focus and not an approach temperament. In addition, for the first time, we showed that the association between health behaviours and self-regulatory dispositions is similar for both the US subgroup and Italian samples and early and middle adulthood participants. With these results, we provided additional confirmatory empirical evidence for Friese and colleagues' model (Friese et al., 2011) in which the approach-avoidance traits are considered psychological determinants that favour health behaviours. We further showed that this association is consistent across age, gender and US subgroup-Italian samples.

Conclusion

To our knowledge, the HRBI is the first questionnaire that analyses the big four health behaviours (as identified by the WHO) using a unique multidimensional instrument. We proposed an initial validation of the HRBI measure testing its construct validity and invariance across age, culture and gender. In addition, we systematically addressed the relationships between self-regulatory dispositions and risk behaviour comparing age, culture and gender effects.

Although promising, our study is not without limitations. First, we did not explore the test–retest reliability, and we did not recruit a sample that also included frequent alcohol and smoker users; therefore, it would be useful for future studies to analyse test–retest reliability and to explore this questionnaire by engaging with a more representative sample for drinking and smoking habits. Second, it is important to emphasise that the male group of the English-speaking sample was composed of a limited number of individuals (N=85); therefore, our results should be considered a preliminary test of invariance over gender in an English-speaking respondent sample. Finally, it would be interesting also to analyse the self-regulatory dispositions and health habits association through a longitudinal study involving a large sample of participants to explore the longitudinal effect of self-regulatory dispositions on the engagement in health behaviour over the lifetime, including adolescents and elderly participants. Future research is called for to fill these gaps and, hopefully, to explore this field of research even further.

Conflict of interest disclosure statement: we have no conflicts of interest to declare

Footnotes:

1. This procedure has led to measuring eating behaviour only through healthy items (selecting low-fat foods or consuming fruit and vegetables) and excludes items that are considered as unhealthy diet behaviour (e.g. consumption of salt and sugar). This technique could raise doubts regarding the content validity of this scale, given that we could not measure the entirety of the construct. However, also in the original version of the instrument, several concerns arose regarding these items measuring unhealthy behaviours (Irish, 2011). In particular, Irish (2011) argued that participants disagreed about the meaning of 'fast food', with definitions ranging from 'anywhere with a drive-thru' to 'any restaurant'. Additionally, when she explored what participants considered to be 'packaged/convenience foods', responses varied widely, including foods such as frozen dinners, condensed soup and frozen vegetables or crackers. In response to the question about 'fried food', one US participant accurately observed that fried foods could refer to foods cooked in a frying pan as well as foods cooked by deep-frying, which represent different health risks.

   In our Italian sample, restaurant and fast foods have different meanings, and Italian participants are less prone to visit fast food outlets (*M* = 1.14, *SD*=.504, *kurtosis* = 37.53). Packaged foods are consumed less in Italy than in the US, and Italians consider frozen dinners as examples of packaged food. Some Italian participants pointed out that a cup of espresso could be considered a sugar-sweetened beverage, and many Italians drink more than two espressos per day, which does not have the same caloric intake as a coke. Finally, some items were poorly phrased ('I added *extra* salt to my food'—extra with respect to what?), and others could be influenced by different cultural habits ('I ate sweets more than once per day'). In Italy, it is common to have a sweet breakfast with cookies, cakes and other sweets; conversely, other nations prefer a savoury breakfast. The difference in these definitions makes the items that we decided to drop inconsistent between participants, as they represent different levels of health risk. Thus, we preferred to exclude those items from the reduced version to have a group of items with a more unequivocal meaning across cultures to allow comparability across nations.

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Table 1

Demographic characteristics of each sample

SAMPLES	*N*	*GENDER*	*AGE*	*EDUCATION*	*OCCUPATION*	*ETHNICITY*	*STATE/REGION*
1. Sample 1 - Pretest *University student sample*	91	M = 20 W = 71	20-50 *M* = 22.41 *SD* = 4.83	HS diploma	All students		University of Cagliari Sardinia (ITALY)
2. Sample 2 - Italian validation *Italian sample* *(HRBI and behavior risk measures)*	626	M = 294 W = 332	18-72 *M* = 26.46 *SD* = 7.19	346 HS diploma 279 bachelor and highest degree (1 missing)	8 unemployed 433 students 181 workers (4-missing)		380 North Italy 218 South Italy (28-missing)
3. Sample 3 - English validation *International sample* *(HRBI; behavior risk measures; approach-avoidance measures)*	304	M = 87 W = 217	18-72 *M* = 28.63 *SD* = 12.03	104 HS diploma 197 bachelor and highest degree	131 students 173 workers	206-Caucasian; 16 Latin-Americans; 10 African Americans 34 Asian Americans 37 others (1 missing)	201 USA; 31 UK; 72 other Nations (Canada, Australia, Asian countries etc.)
4. Sample 4 - Invariance test *Italian sub-sample of* *Sample 2* + *International sample (Sample 3 - see demographics characteristics above)*	304 304	M = 136 W = 168	18-59 *M* = 26.51 *SD* = 7.2	175 HS diploma 128 bachelor and highest degree (1 missing)	4 unemployed 211 students 87 workers (4-missing)		190 North Italy 103 South Italy (11-missing)
5. Sample 5 - HRBI Scores distribution *General Italian sample =* *Sample 2 + Sample 6a* + *International sample (Sample 3 - see demographics characteristics above)*	939 304	M = 445 W = 494	18-72 *M* = 28.66 *SD* = 9.758	491 HS diploma 447 bachelor and highest degree (1 missing)	18 unemployed 563 students 354 workers (4 missing)		453 North Italy 452 South Italy 6 residing abroad (28 missing)
6. Sample 6 - Approach-Avoidance and HRBI **Sample 6a** – *Second Italian sample (HRBI and approach-avoidance measures)* + *International sample (Sample 3 - see demographics characteristics above)*	313 304	M = 151 W = 162	18-64 *M* = 33.05 *SD* = 12.4	145 HS diploma 168 bachelor and highest degree	11 unemployed 130 students 172 workers		73 North Italy 234 South Italy 6 residing abroad
7. Sample 7 - Differences USA/ITA: *USA sub-sample of Sample 3* + *Sample 6a* *(see demographics characteristics above)*	201 313	M = 69 W = 132	18-72 *M* = 28.21 *SD* = 12.92	87 HS diploma; 114 bachelor and highest degree	85 students 116 workers	163 Caucasian 14 Latin-Americans 8 African Americans 14 Asian Americans 2 others (1 missing)	All USA

Table 2

Distribution of HRBI scores in the Italian and International samples

HRBI SCORES DISTRIBUTION												
	General Italian sample-Sample 5						***International sample-Sample 3***					
	Min	***Max***	***Mean***	***SD***	***Skew***	***Kurt***	***Min***	***Max***	***Mean***	***SD***	***Skew***	***Kurt***
HRBIpi	1	5	3.48	1.21	-.40	-.95	1	5	3.35	1.07	-.23	-.85
HRBIud	1	5	2.62	.78	.17	-.43	1	5	2.68	.78	.18	-.21
HRBIs	1	5	2.25	1.08	1.11	.06	1	5	1.76	.83	1.86	3.17
HRBIa	1	4.17	1.37	.52	2.32	5.80	1	5	1.46	.65	2.03	5.00
HRBI TOT	1.11	4.44	2.43	.56	.44	.59	1	4	2.31	.50	.25	.10

Note. Min and Max represent the items average score calculated for each HRBI scale. HRBIpi = HRBI physical inactivity; HRBIud = HRBI unhealthy diet; HRBIs = HRBI smoking; HRBIa = HRBI alcohol.Sample 5 (N=939); Sample 3 (N=304)

Table 3

Items selected from the original HRBI – EFA on Sample 1

Original Item	*Physical Inactivity*	*Unhealthy diet*	*Smoking*	*Alcohol*	*New Item #*
3.*I participated in a sport that requires a lot of physical effort (for example, singles tennis, basketball, soccer, or other sports that require similar amounts of physical effort).	**.918**	-.044	.014	-.238	**HRB6r**
4. *Each weeks, I got at least 2 ½ hours of aerobic exercise from activities other than sports (exercise that increases heart rate, respiration and sweating like jogging, elliptical, aerobics classes or other similar activities)	**.829**	.219	.169	-.330	**HRB9r**
6. *I did resistance training (like lifting weights) at least twice a week.	**.788**	.020	.024	-.246	**HRB14r**
7. *During my free time, I participated in recreational activities that involve physical effort like hiking, swimming, golf, bowling, or other activities that involve some physical effort.	**.869**	.149	.085	-.126	**HRB16r**
1. My work involved sitting for long periods (Note: "Work" refers to traditional employment as well as childcare, housework and school).	.272	-.036	-.209	.218	
2. *My work involved standing, moving and/or lifting (Note: "Work" refers to traditional employment as well as childcare, housework and school).	.254	.177	-.155	.056	
5. *I participated in light physical activities like leisurely walking or stretching that don't really raise my heart rate or make me sweat much.	.275	.348	-.015	.380	
8. During my free time, I usually sat and relaxed (for example, watched TV, read, or other activities that don't require much physical effort).	.407	.557	-.108	.059	
9. Each day, I spent at least 4 hours watching TV, reading, or playing computer games.	.071	.344	-.074	.262	
10. *I walked or biked to my destinations, rather than driving	-.264	-.268	-.101	-.234	
11. *I ate vegetables more than twice per day (Note: Eating multiple servings of vegetables in the same sitting counts as multiple times per day).	.095	**.537**	.134	-.329	**HRB1r**
12. *I ate fruit more than once per day (Note: Eating multiple servings of fruit in the same sitting counts as multiple times per day).	.138	**.590**	.188	-.189	**HRB3r**
13. *I chose foods made with whole grains (such as whole wheat bread, cereal, or pasta) over foods without whole grains (such as white/enriched bread, cereal, or pasta).	.116	**.585**	.146	-.205	**HRB7r**
15. *I chose low fat/fat free dairy products (milk, cheese, yogurt) rather than regular dairy products.	.024	**.591**	.003	-.155	**HRB11r**
17. *I ate breakfast every day.	-.076	**.541**	.104	.181	**HRB17r**
18. I went out for fast food four or more times per week.	-.523	.189	-.347	.628	
21. I ate sweets more than once per day.	-.059	.328	-.045	.160	
22. I ate so much that I was too full or felt "stuffed" after eating.	.137	.239	.224	.401	

14. I added extra salt to my food.	-.144	.456	-.036	.177	
16. I drank at least 2 sugar-sweetened beverages per day (for example, non-diet soda, sweet tea, Kool-Aid, or other sweetened beverages).	-.234	.482	.151	.127	
19. *I did not eat fried foods (for example, french fries, fried chicken, donuts, or other foods cooked by frying).	.008	.447	.014	.122	
20. I ate packaged convenience foods at least once per day (for example, frozen dinners, canned pastas, condensed soup or other packaged foods).	.071	.157	.061	-.208	
33. I had a cigarette within one hour of waking up in the morning.	.093	.313	**.917**	.103	**HRB4**
34. I smoked at least 10 cigarettes per day.	.101	.356	**.965**	.050	**HRB8**
35. I smoked at least one cigarette per week.	.073	.127	**.934**	.116	**HRB10**
36. *I did not smoke cigarettes.	.120	.079	**.949**	.146	**HRB12r**
38. *I avoided people while they were smoking.	.135	.343	**.583**	-.065	**HRB18r**
39. I was exposed to secondhand cigarette smoke.	-.104	.104	**.509**	.032	**HRB19**
32. I smoked part or all of a cigarette	.061	.137	*.990*	.129	*Double statement item-deleted*
37. I allowed people to smoke in my car.	-.133	.244	.373	.475	
40. *No one was allowed to smoke in my home.	.016	.113	.304	.215	
41. I drank 5 or more drinks (if male) or 4 or more drinks (if female) in one day.	-.133	.069	.592	**.673**	**HRB2**
42. I drank 5 or more drinks (if male) or 4 or more drinks (if female) several days per week.	-.251	.205	.379	**.788**	**HRB5**
45. Someone in my life talked to me about my drinking because they were concerned.	.083	-.038	.110	**.817**	**HRB13**
46. Once I began drinking, it was difficult for me to stop.	-.092	.147	.480	**.803**	**HRB15**
48. I drove after drinking 2 or more drinks.	-.030	.328	.346	**.610**	**HRB20**
49. I got into trouble because of my drinking.	-.069	.119	.592	**.707**	**HRB21**
43. *I drank some alcohol (2 or fewer drinks per day for males or 1 or fewer drinks per day for females).	.111	-.021	.103	.069	
44. *I did not drink alcohol.	-.149	.029	.544	.499	
47. *Drinking or being hungover did not interfere with my usual activities or responsibilities (like work, school, family responsibilities).	.189	-.051	.080	-.173	

Table 4

CFA Factor Loadings of HRBI on Italian and English version

	Italian version					*English version*				
	HRBIpi	***HRBIud***	***HRBId***	***HRBIa***	***SD***	***HRBIpi***	***HRBIud***	***HRBId***	***HRBIa***	***SD***
HRB6R	.873**				.237	.718**				.484
HRB9R	.787**				.381	.847**				.283
HRB14R	.779**				.393	.740**				.452
HRB16R	.793**				.371	.824**				.320
HRB1R		.541**			.707		.668**			.553
HRB3R		.660**			.565		.750**			.437
HRB7R		.584**			.659		.603**			.636
HRB11R		.546**			.702		.441**			.806
HRB17R		.506**			.744		.400**			.855
HRB4			.968**		.063			.973**		.054
HRB8			.944**		.110			.969**		.061
HRB10			.997**		.005			.987**		.025
HRB12R			.961**		.077			.899**		.193
HRB18R			.694**		.519			.696**		.516
HRB19			.625**		.610			.605**		.634
HRB2				.886**	.214				.882**	.222
HRB5				.834**	.304				.862**	.257
HRB13				.754**	.431				.882**	.223
HRB15				.822**	.320				.824**	.321
HRB20				.594**	.643				.670**	.552
HRB21				.806**	.324				.877**	.231
HRBIud	.432**					.489**				
HRBIs	.013	.199**				.079	.207*			
HRBIa	.008	.281**	.665**			-.184*	.117	.550**		

Note. HRBIpi=HRBI physical inactivity; HRBIud=HRBI unhealthy diet; HRBIs=HRBI smoking; HRBIa =HRBI alcohol.

Table 5

Invariance of HRBI over Italian-English language, age and gender

Italian-English Invariance	χ^2	*df*	*CFI*	*TLI*	*RMSEA*
CFA	451.055**	183	.981	.978	.049
CFA English	322.455**	183	.976	.973	.050
CFA Italian	292.163**	183	.987	.985	.044
M0-CFA sample groups	820.529**	443	.974	.975	.053
M1-Configural	622.601**	367	.982	.980	.048
M2-Metric	658.809**	383	.981	.979	.049
M2-Scalar	820.655**	443	.974	.975	.053
M4-Residual variance	820.655**	443	.974	.976	.053
M5-Variance Covariance	824.735**	452	.974	.976	.052
M6-Mean	974.560**	456	.964	.967	.061
Age Invariance	χ^2	*df*	*CFI*	*TLI*	*RMSEA*
CFA	451.055**	183	.981	.978	.049
CFA below 25	388.434**	183	.970	.966	.060
CFA above 25	279.092**	183	.986	.983	.042
M0-CFA sample groups	769.735**	442	.976	.977	.049
M1-Configural	666.520**	366	.978	.974	.052
M2-Metric	689.805**	383	.977	.975	.051
M2-Scalar	769.755**	442	.976	.977	.049
M4-Residual variance	796.787**	442	.976	.976	.049
M5-Variance Covariance	678.674**	452	.983	.984	.041
M6-Mean	708.668**	456	.981	.983	.043
Gender Invariance	χ^2	*df*	*CFI*	*TLI*	*RMSEA*
CFA	451.055**	183	.981	.978	.049
CFA Female	354.611**	183	.983	.980	.049
CFA Male	299.115**	183	.973	.968	.053
M0-CFA sample groups	744.417**	442	.979	.980	.047
M1-Configural	651.423**	366	.980	.977	.051
M2-Metric	677.428**	383	.980	.978	.50
M2-Scalar	744.419**	442	.979	.980	.047
M4-Residual variance	758.535**	463	.980	.981	.046
M5-Variance Covariance	753.783**	473	.981	.983	.044
M6-Mean	809.606**	477	.977	.980	.048

Note. For English-Italian invariance CFA English version in International sample (Sample 3); CFA Italian version in Italian sample (Sub-sample 2). For gender invariance female sample N=385; male sample N=223. For age invariance Below 25 sample N=308; Above 25 sample N=300.

Table 6

Correlation matrix between HRBI and health behavior questionnaire

	Sample 2 Italian Sample				*Sample 3 International Sample*			
	IPAQT	***FHAB***	***FT***	***AU***	***IPAQT***	***FHAB***	***FT***	***AU***
HRBIpi	**-.342****	-.246**	.009	.029	**-.634****	-.344**	.023	-.170*
HRBIud	-.175**	**-.849****	.181**	.250**	-.118**	**-.797****	.159*	.124
HRBIs	.104*	-.264**	**.774****	.443**	-.038	-.309**	**.638****	.434**
HRBIa	.168**	-.386**	.447**	**.726****	.027	-.290**	.263**	**.729****
FHAB	.077*				-.064			
FT	.121**	-.238**			-.002	-.173*		
AU	.135**	-.301**	.379**		.037	-.207*	.274**	

Note. HRBIpi=HRBI physical inactivity; HRBIud=HRBI unhealthy diet; HRBIs=HRBI smoking; HRBIa =HRBI alcohol; IPAQT=International Physical Activity questionnaire-physical activity; FHAB=Food habit questionnaire-healthy diet; FT= Fagerström Nicotine Dependence Test-smoking; AU=AUDIT-alcohol.

Table 7

Invariance over nationality, age and gender and SEM regression model of self-regulatory dispositions on health risk behaviors

		INVARIANCE			
NATIONALITY	χ^2	*df*	*CFI*	*TLI*	*RMSEA*
CFA	1818.470**	874	.936	.931	.046
CFA USA	1369.172**	874	.906	.900	.053
CFA ITA	1411.076**	874	.941	.937	.044
M0-CFA sample groups	3218.085**	1932	.907	.909	.051
M1-Configural	2781.061**	1749	.925	.919	.048
M2-Metric	2850.006**	1786	.923	.918	.048
M3-Scalar	3218.087**	1932	.907	.909	.051
M3a-Partial Scalar	3090.472**	1925	.916	.917	.049
M4-Partial Residual variance	3201.855**	1968	.911	.914	.049
M5-Partial Variance Covariance	3143.264**	2004	.917	.922	.047
M6-Partial Mean	3246.389**	2012	.911	.916	.049
AGE	χ^2	*df*	*CFI*	*TLI*	*RMSEA*
CFA	1818.470**	874	.936	.931	.046
CFA below 25	1258.437**	874	.915	.908	.045
CFA above 25	1411.197**	874	.944	.940	.045
M0-CFA sample groups	2918.576**	1931	.928	.930	.045
M1-Configural	2661.406**	1748	.934	.928	.045
M2-Metric	2697.426**	1784	.934	.930	.045
M2-Scalar	2918.579**	1931	.928	.930	.045
M4-Residual variance	2926.597**	1967	.928	.929	.045
M5-Variance Covariance	2873.955**	2003	.934	.937	.042
M6-Mean	2922.996**	2010	.931	.934	.043
GENDER	χ^2	*df*	*CFI*	*TLI*	*RMSEA*
CFA	1818.470**	874	.936	.931	.046
CFA female	1284.743**	874	.961	.958	.040
CFA male	1320.950**	874	.901	.892	.048
M0-CFA sample groups	2863.883**	1931	.937	.939	.043
M1-Configural	2652.074**	1748	.939	.934	.045
M2-Metric	2701.291**	1786	.938	.935	.045
M2-Scalar	2863.879**	1931	.937	.939	.043
M4-Residual variance	2936.192**	1975	.935	.938	.044
M5-Variance Covariance	2873.359**	2011	.942	.945	.041
M6-Mean	3142.724**	2019	.924	.929	.047
FEMALE DEVIATION FROM MALE	***Female mean (sd)***	***pvalue***			
HRBI physical inactivity	.499 (.100)	.000			
HRBI unhealthy diet	-.245 (.107)	.022			
HRBI smoking	-.072 (.103)	.486			

HRBI alcohol	-.394 (.115)	.001		
Approach temperament	.087 (.099)	.380		
Avoidance temperament	.697 (.100)	.000		
Promotion focus	-.314 (.107)	.003		
Prevention focus	.215 (.099)	-.030		
	REGRESSION MODEL			
	HRBIpi	***HRBIud***	***HRBIs***	***HRBIa***
RFQ pro	**-.471***	**-.341***	**-.367***	**-.278***
RFQ pre	**.168***	-.046	**-.288****	**-.370****
ATQ ap	.091	.022	.174	.110
ATQ av	-.071	-.200	**-.220***	-.133

Note. In nationality and age invariance USA participants belong to the sub-sample of Sample 3, Italian (ITA) participants belong to Sample 4. In gender invariance Partial scalar invariance and following level of invariance has been calculated excluding items ATQ9 and HRBI17. HRBIpi=HRBI physical inactivity; HRBIud=HRBI unhealthy diet; HRBIs=HRBI smoking; HRBIa =HRBI alcohol