

## On Features and Measures of Psychological Wellbeing

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### Abstract

Low levels of psychological wellbeing pose considerable burdens on society in terms of mortality, unemployment, absenteeism, medications, social services, morbidity, and in-out patients' costs. Early detection and preventive treatments may help to reduce costs and improve quality of life. Researchers have proposed several measures and tried to identify new measures of psychological wellbeing, but there is not a universally accepted measure, and all the existing ones have their own limitations. This paper discusses research results focusing on behavioral, psychological, social, demographic features and biomarkers of psychological wellbeing and mental disorders associated with low psychological wellbeing levels. The features which are addressed in the paper are categorized into three groups: affecting features, features for therapy and detecting features. This categorization is described and defended.

**Keywords:** Psychological Wellbeing, Subjective Wellbeing, Mental Health, Psychological Wellbeing Features

## Introduction

Psychological wellbeing (PWB) is universally relevant, even though, currently, there is no single conceptual understanding of psychological wellbeing. We begin by supposing that such a conception is possible and coherent, and label that construct as “PWB”. We seek to identify factors that can be manipulated to improve PWB and PWB markers to detect changes in PWB levels. A widely used definition considers PWB as the combination of feeling good and functioning effectively [1,2]. Another widespread concept of PWB is described by the six-dimensional model proposed by Ryff [3]. The model includes, as dimensions of wellbeing, positive relations, autonomy, environmental mastery, personal growth, purpose in life, and self-acceptance. Some researchers distinguish PWB from subjective wellbeing (SWB). SWB refers to people’s self-reported or experienced well-being as combination of life satisfaction, high levels of positive affect, and low levels of negative affect [4]. PWB and SWB are two distinct but directly related concepts [5], which separately or jointly are used by researchers to determine the individuals’ levels of wellbeing. These concepts prepare the grounds for discussions and further investigations on features and measures affecting changes in PWB. In this paper following the definition of mental health provided by the World Health Organization (WHO), PWB is defined as “a state of wellbeing in which the individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community” [6].

The World Health Organization (WHO) consider health “A state of complete physical, mental and social wellbeing and not merely the absence of disease or infirmity”, hence “mental health promotion involves actions that improve psychological wellbeing” [6]. PWB levels are directly associated with mental health [7-9] and reliable predictors of physical and mental disorders [10,11]. People with high levels of PWB suffer fewer illnesses, have an increased life expectancy, and engage themselves in healthier behaviors [10,11]. Low levels of PWB are associated with several mental disorders such as depression, anxiety, stress, mood disorders, eating disorders, personality, and sleep disorders [12-14]. These disorders pose considerable burdens on public health care centers with undesirable costs for individuals, families, and societies. Mental disorders have negative effects not only on patients but also on their families, their social-and work-related environments, and social care costs [15]. Relationships between economic factors and mental disorders have been reported to impact the economy of societies in terms of health care, welfare and lost productivity [16,15]. The costs of mental illnesses for the European Community were estimated to be more than €600 billion per year in 2015 [17]. In the United States, the National Institute of Mental Health estimated that in 2019, 20.6% of all US adults were suffering a mental illness [18,19], and the Lancet Commission on global mental health estimated that the world cost of mental illness would be about US\$16 trillion over the period 2010-2030 [20]. This increasing economic burden on society, globally, associated with mental disorders makes extremely relevant measurements of PWB levels, since their decline is directly associated with mental disorders: it is vital then to seek and identify physiological, psychological and affective variables able to provide indications on individuals’ PWB levels. None of current identified PWB factor dominate as “gold standard” [2], and all the existing ones have their own advantages and limitations. Currently, the most widespread tool for detecting PWB levels is by administering questionnaires. The most widely used are e The Psychological General Well Being Index [160], the Warwick-Edinburgh Mental Wellbeing Scale [161], Riff’s Psychological Wellbeing Scales [3]). However, PWB levels, are time-varying and strongly affected by individuals’ dynamic emotional states [21,22], raising the need to identify dynamic measures for PWB levels. This paper intends to report on current PWB measures, discuss their advantages and drawbacks, unifying for the first time, to our knowledge, what have been identified as affecting, therapeutic and detecting features. of PWB. We will discuss on qualities that have been shown to interact with PWB levels, depending on the measurement used (identifying these as “affecting features”). We highlight the measurable qualities over which individuals may have some levels of conscious influences on PWB (discussing these as “therapeutic features”), and distinguish those from qualities that show correlation with PWB that appear to be at best only indirectly amenable to influence it (naming all these “detecting features”). Our paper thus provides a comprehensive review of PWB detection issues. By reporting on different PWB measures, we open the possibility of cross-calibration across modalities, thereby increasing the accuracy and reliability of PWB level estimates. We see this three-part classification of PWB measures as providing a conceptualization of the literature that both enhances the literature and offers didactic value. The paper provides a first inclusive literature review useful in educational courses to assist novice learners in the understanding of PWB multifaceted literature and carry out comparative experimental evaluations of different PWB features. Finally, our analysis may contribute to guide the choice of new approaches investigating on accurately detection of PWB levels.

This is done by identifying currently published studies (between 2009-2021), which introduce the PWB theoretical framework along with the three categories of features (affecting, therapeutics, and detecting features) that deserved to be considered to enhance the accuracy and reliability of estimating PWB levels.

## Theoretical Framework

The theoretical framework that we adopt in analyzing research into PWB presupposes that PWB is a mental equilibrium as an ideal but that as there are many dimensions along which such an equilibrium may be disrupted, there is a partial ordering of states of PWB that amount to greater or lesser PWB. Because the dimensions are in some cases independent and in other cases overlapping, measurements of PWB give results that both depend upon the dimension of operationalized assessment and, yet, is not deterministic in relation to any single dimension. That is, for example, greater PWB may be expected with greater states of physical fitness, but it is not unexpected to find individuals in great states of physical fitness and low states of PWB, and vice versa. Dimensions that contribute to PWB may be analyzed with respect to salient oppositions: (human) internal vs. external, mental vs. physical, individual vs. social, local vs. distal, etc. Within these oppositions and their overlapping aspects, further contrasts are, of course, also germane. For example, within the internal, physical dimension there are natural contrasts that arise according to degree of health in the brain and nervous system or in the muscle and skeleton system. The level of description of the theoretical framework which understands PWB as commensurate with equilibrium is essentially the same that Galen used in describing general health as balance [162]. A more detailed specification of Galen's framework involves a distinction between hygiene and therapeutics, where "hygiene" is about maintaining a state (of health) and "therapeutics" addresses changing a state (towards improved health). The corresponding more detailed view of the framework that we adopt distinguishes affecting features, therapeutic features and detection features of PWB. Affecting features are those which do not have a causal influence on levels of PWB, but which provide dimensions along which significant differences in PWB may be seen, especially in combination with other features (e.g., gender combined with regional economic stability). Therapeutic features are those aspects of PWB that are amenable to conscious "exercise" in maintaining a level of PWB or changing state towards improving levels of PWB. Detection features are those which are diagnostic of levels of PWB, but which are not necessarily amenable to conscious control (such as EEG patterns).

Because of the multi-dimensional nature of PWB, like that of general health, it is not clear that a state of perfect PWB is actually attainable, even though it is part of popular discourse to refer to such ideal states. Notably, this generally happens to highlight contrasts with ideal states. It is useful to reflect on the respective transparency of general health and PWB to introspective evaluation. While both are somewhat transparent, it appears rather more likely that someone who has been feeling good healthy may be convinced by an expert that they have a very serious medical condition that has not yet impinged on the individual's consciousness than that someone who feels to be in good PWB can be convinced by a professional that they are not in a state of good PWB. Divergences from high levels of PWB that are not available to individual introspection seem to be socially determined—whether someone is happy in association with being delusional requires independent judges of the delusional states. Nonetheless, the transparency of these states and general methods of making precise pre-theoretic notions associated with scientific concepts makes self-perception of PWB the starting point for any analysis of PWB. Thus, measures of operationalized dimensions of PWB are generally understood with reference to questionnaire data.

We understand this theoretical framework to provide a unifying approach to specific theoretical models of PWB. For example, one six-factor model emphasizes [23]: autonomy, environmental mastery, personal growth, positive relations with others, purpose in life, self-acceptance. These factors can be seen to invoke the contrasts internal and external physical states as well as individual and social states. Similarly, the specific factors that result from independent exploration of variables [24] also invoke such contrasts: the first major factor there encompasses "general psychological well-being" [24, p. 40] and includes components of affect, cognition, behavior, self-concept, interpersonal relationships, absence general symptoms of mental disorder. These, too, show contrasts in internal and external conditions. Stepping back from specific theoretical models within a theoretical framework encourages exploration and cataloguing of the wider range of specific qualities that have been found to impinge on PWB, we note that some of these will be seen as affecting features, some as therapeutic features, some as detection features. Mindful of this theoretical

framework and the theoretical distinctions we have addressed, we provide a review of recent and relevant literature that addresses features of PWB.

## Methods

This paper discussed academic results (e.g., reported in original articles and dissertations) focusing on behavioral, psychological, social and physical PWB features and mental disorders associated with low PWB level. The proposed investigation stated on February 2019 and was concluded at the first submission date of the current paper. The studies considered have been published from 2009 to 2020. Google scholar was used for the article searching process. The combination of terms from the first group (psychological wellbeing, subjective wellbeing, mental health, depression, anxiety) and filtered by a second group (physical activity, sleep patterns, sleep difficulties, insomnia, hypersomnia, sleep problems, body language, gestures, body movements, facial expressions, Social interactions, Facebook, social networks, demographic variables, social isolation, creative activities, art, gender, age, marital status, education, income, residency, behavioral patterns, character strength, EEG signals, brain activity, speech patterns, speech, acoustic features, prosodic features, linguistic features, cortisol, chronic physical conditions, body mass index) were used for the searching process.

Research using only terms of the first group retrieved, as expected, a high number of articles (18,800 articles). These were reduced to 173 studies when the other terms were included. In addition, from the 173-paper selected were excluded all papers published before 2009, not written in English, with missing data, identified bias, and dealing with PWB features that would be not included into the three identified categories, i.e., affecting, therapeutic and detecting features. This reduced the discussed papers to 134.

## Results

### Behavioral PWB Features

Patterns of behavioral features or their abrupt change can be a measure of PWB variations' level. In this section the following five behavioral features are considered: physical activity and sleep patterns.

**Physical Activity:** There is evidence that different sorts of physical activity (PA) have a positive correlation with individuals' PWB. It has been shown that activities such as endurance and gym training improve subjective health, and moderate activities such as walking and ball games are positively correlated with emotional wellbeing [25]. The environment where physical activities are undertaken affects the obtained health benefits. Lawton and colleagues [26] showed that regular outdoor physical activities produce "higher levels of wellbeing and lower levels of trait anxiety" (p. 8) than activities undertaken indoor. Wiese and colleagues [27] in a meta-analysis including 27 studies reported correlational relationships and positive effects of physical activities during leisure time on SWB.

Six weeks or more of physical activities related to endurance, muscle strengthening, and resistance exercises, such as aerobic exercises have been proved to reduce anxiety, depression, mood disturbance and improve life satisfaction [28]. PA's positive impact on subjective wellbeing and health was proved to be effective for children [29], adults [30], elders [31] and clinical samples [32-34]. Several studies demonstrate evidence that mild physical activities are mostly beneficial for women for distress reduction purposes, while intense physical activities are of more benefit for men [35]. Therefore, positive relationships between PA and subjective wellbeing are strongly affected by gender differences, types of preferred sports (personally chosen by men and women) and gender responses to stress [36].

Some studies have investigated the relationship between changes in PA over time with physical and mental health functioning. Holstila and colleagues [37] had shown that mental health and physical functioning improve with increased physical activities and decline independently from the intensity of the undertaken PA. Panza and colleagues [38] further supported these results

showing that subjective wellbeing is low in samples undertaking sedentary behaviors and that the intensity of the undertaken PA may affect differently but always positively the three important domains (psychological wellbeing (PWB), depression, pain severity) that measure subjective wellbeing. Finally, benefits derived from PA are affected by its volume and context, particularly among the young. Doré and colleagues [39] showed that increased PA in leisure time is negatively associated with mental disorders such as depression and anxiety among post-secondary school students. PA carried out in informal and/or sport teams reduce loneliness and produce better results in terms of mental health functioning and mood disorders than PA undertaken in isolation. These results were further supported by Andersen and colleagues [40] who proved that their implementation is “more efficient in promoting health and ensuring exercise participation and continuation than individual sport”, provided precautions are taken to account for the competitive nature of team sports [40, p. 1].

Despite the numerous studies investigating relationships between PWB and PA, a unifying relationship is still missing. Different PA have various characteristics (outdoor or indoor, social or solitary, more or less intensive, type of training etc.) and different PA are related to different psychological benefits [25]. Longitudinal associations remain unclear and debatable given that most of the current studies either associate PA with current level of PWB or otherwise longitudinal associations were reported only for specific age groups such as middle-aged and elders [25,41,42].

**Sleep Patterns:** Poor sleep and/or insomnia have a significant negative effect on health and wellbeing [43,44]. Sleep problems are often associated with mental health problems [45,46]. When lasting one year or more, sleep problems significantly increase the risk of developing mental disorders such as bipolar and anxiety disorders, suicidal ideation, and especially depression [47]. A substantial number of studies report that sleep problems lasting 12 months or longer are significantly correlated with the onset of severe depressive disorders [48-51] and anxiety [48,52] in non-clinical samples of adults. In addition to causing mental health problems, poor sleep, insomnia, but also hypersomnia is associated with depression [53], it has been shown that, among depressed patients about 15-35% suffer of hypersomnia [54]. However, the association between depression and hypersomnia need to be furtherly investigated, since, to date, hypersomnia estimates have been based on single questionnaires' responses, neglecting anamnesis on night sleep quality [53]. Nevertheless, not only insomnia and hypersomnia have a negative effect on good level of PWB, they have also been tied to bedtime attitudes. Zhang and colleagues [55] reported that later bedtime (after 22:30) and less than 7 hours of sleep are associated with the definitions of “inadequate quality of sleep” and this condition increases the likelihood of developing anxiety, mood and behavior disorders, suicidal intentions and other mental disorders. Additionally, there is evidence that continuous sleep disturbances (such as an increase of sleep latency, elevated number of intermittent awakenings, and early morning awakenings) also arouse anxiety and depressive disorders [56,54]. The severity of these disorders may vary according to which sleep phases (wake, sleep stage 1, sleep Stage 2, slow-wave sleep, REM sleep) are affected. Baglioni and colleagues [56] reported that anxious and depressed patients have shortened slow-wave sleep, with no changes in the other sleep phases. However, currently, there is not clear evidence on which sleep phase can be associated with and be predictive of mental disorders [57].

## Social PWB Features

**Body Language:** A person's emotional condition and feelings are reflected in their gestures and facial expressions [58]. Facial expressions and body movements are non-verbal ways of communication [59]. Data suggest that body language accounts of more than 60% of meaningful communication [60,61]. Canales and colleagues [62] demonstrated that body movements of depressed patients' (major depressive disorder) are significantly different from those of a control group, with depressed patients showing increased head flexion and thoracic kyphosis, left pelvic retroversion and abduction of the left scapula, and significant differences in shoulders' positions. However, several studies highlighted that to give a value to these differences it is important pay attention to context in which body movements are made. Body language analyses must be performed on selected groups of movements rather than be focused on deriving actions [60].

**Facial Expressions:** In addition to the body language, facial expressions carry significant information in the detection of states of PWB. There is a 35% likelihood to increase the success of interactional exchanges when messages are simultaneously read from both face and body (e. g. [63]). A significant decrease in facial activity in general is related to depression, whereas increased facial activity is associated with SWB improvement [64]. Investigating separate face features e.g., eye movement, smile etc. also contribute to PWB level detection. There are data showing that socially anxious patients hold their eyes longer on threatening [65-67] and smiling faces [65]. Additionally, Wieser and colleagues [68], using virtual reality, demonstrated that women with social anxiety compared to a control group increasingly avoid direct gaze of men (among female students recruited as participants in a German university, n=162). Furthermore, Girard and colleagues [69] reported more contempt and less smiles on depressed patients' faces, with smiling often associated with contempt rather than happiness. However, it is also known that there are different categories of smiles performing various social functions, other than reflecting feelings (e. g. [70,71]). Attributing depressive states to individuals not expressing smiling faces can be debated and more investigations are required to assess this issue [72]. Finally, there is evidence in the academic literature that temporal facial dynamics provide more information and more useful for depression detection than using static facial expression information only [64].

**Social Interactions:** There is data that perceived emotional support and perceived negative interactions have some effect on a person's PWB. In a systematic review, Santini and colleagues [73] investigated 35 studies which focused on the association between social support variables and depression, a significant association was established in 32 over the 35 studies and it was concluded that high level of perceived emotional support is helpful in preventing depression, while low level are linked to the onset or presence of depression. However, 5 of the 35 studies focusing on both perceived emotional support and perceived negative interactions, reported mixed or contradictory results. Moreover, in that same review 7 studies were investigating on perceptual differences in receiving emotional support and/or perceiving negative interactions either from family members or friends. Five of these studies reported a significant effect from both sources of social support to predict depressive states. However, in the remaining 2 studies effects from friends' support were not strongly established.

The size of social networks can be a significant predictor of PWB as well. In many studies, it has been shown that large established social networks prevent older adults from being affected by depression [74-80]. However, it was also shown that older adults' social isolation is not a predictor of depressive symptoms (e.g. [81]). Chao [75] suggested that it is necessary a combination of diverse social networks, appropriately sized (such as 25-50% family and 50-75% friends) to effectively reduce individuals' isolation. However, also the quality of the network (lack of connection with depressed persons) is important. Rosenquist and colleagues [82] demonstrated a positive correlation between individuals own depressive states and depressive conditions of their friends and neighbors.

Cacioppo and colleagues [83] claimed that loneliness is another significant predictor of depression and is independent from demographic variables, objective social isolation and received/perceived social support. The evidence comes from their 5-year longitudinal study proving that both the loneliness and a rather small social network are significant predictors of depressive symptoms. Chan and colleagues [74] reported that this association is more effective for women. However, Sonnenberg and colleagues [80] concluded that men demonstrate higher rates of depression, related with loneliness, compared with women. Despite the evidence above, Santini and colleagues [73], in a systematic review including 51 studies, reported only a little evidence for the association between social connectedness and depression.

Online social interaction is becoming a widespread and important part of peoples' interactional exchanges. The most popular and widely used online social networks in the world is Facebook [84]. There are controversial data about the effect of online social networks to PWB. Some researchers concluded that intensive online interactions can be associated with positive effects on PWB level [85,84]. Others researchers reported opposite effects showing that intensive online interactions can lead to depression and loneliness [86,87], and others showed that both effects can occur [88]. Hu and colleagues [88] investigated students' Facebook intensity of use and its association with PWB levels showing that there can be observed either positive or negative effects on PWB level depending on students' extroversion/introversion characters. Positive effects in using intensively Facebook were more

significant for introverted individuals. Finally, other researchers attributed to social networks users' motivations the arousal of positive or negative individuals' reactions, and showed that using Facebook for maintaining real-life friendships has a positive effect on PWB, while using it for establishing new connections (e.g. making new friends) is associated with negative effects on PWB [89].

**Creative Activities:** There is some evidence that arts, in general, can improve health and PWB level not only of non-clinical adults and elders but also clinical ones. Grossi and colleagues [90] investigated 1,500 adults and established that opportunities for cultural participation is the second most important determinant of PWB (after absence or presence of diseases). In more recent study, Davies and colleagues [91] investigated the association between recreational arts engagement and PWB level in 702 adults. They concluded that 100 hours/year or more arts' engagements have a significant positive effect on PWB level. Todd and colleagues [92] and Thomson and colleagues [93] showed a positive effect of museum-based activities on older adults' wellbeing. A project designed by Colbert and colleagues [94] engaged 12 individuals with psychosis in 4 galleries' visiting sessions and 10 out of 12 participating to all sessions reported that "the project had contributed to their wellbeing".

Despite these proofs attributing to creative activities significant positive effects on PWB level, some researchers suggested more investigations objecting on the complexity to isolate these positive effects of creative arts from other variables (e.g. [95]). Leckey [95] in a review including 11 studies, showed a protective effect on PWB level of creative activities. However, they underlined the difficulty "to make comparisons of the [reported] studies being evaluative in nature and untaken within local projects, therefore, lacking in generalization" [95, p. 1].

Several authors maintained that since during creative activities, people evaluate artworks (e.g. sculpture, music, visual arts, etc.) which produce both certain emotions and engage them into in an aesthetic experience, it is trivial to observe an upsurge of PWB level (e.g. [96-98]). However, the review proposed by Mastandrea and colleagues [97] investigating the association between aesthetic experience and PWB level concluded that this positive association must be furtherly investigated to overcome the limitations of the proposed studies.

## Demographic PWB Features

Demographic features are features that allow to categorize people. These features are age, gender, marital status, education, incomes, and residency. Their effects on PWB level are easily measurable.

**Gender and Age:** There is statistical evidence about differences between gender, age and individuals' PWB. Several authors suggested that age and gender are main factors associated with life satisfaction and directly correlated with PWB level (e.g. [99]). In general, it has been shown by numerous studies that females PWB level are lower than males ones (e.g. [90,100-103]). In addition, there are data showing that PWB levels decrease with age [100,99,102], and this decrease is significantly higher in female rather than male individuals [103]. It has also been reported that this decrease is observed in the age range between 55 and 64 years, and then it stays stable with no considerable sex-related differences after this age [103]. These data deserve further investigation, since contradictory results have been also reported. Particularly, Lincoln and colleagues [101], in a study involving respondents from different nationality (African Americans, non-Hispanic whites, blacks of Caribbean descent) observed lower PWB level in young rather than older adults. Finally, several researchers questioned the significance of ageing effects on PWB level suggesting that it can be caused, at least in part, by methodological artifacts. Specifically, Springer and colleagues [104] reported that "longitudinal age variations never accounting for more than 4%" [of PWB level' variations] and "far greater variations within ages or periods than between subscales across age or time" have been observed.

**Marital Status:** Family relationships in general, and marital status in particular, are enduring and consequential variables of health and positive PWB level. There is evidence that married participants demonstrated higher PWB level than single and divorced respondents (e.g. [101,103,105]). However, there is data that correlation between marital status and PWB changes over time. This

suggestion was made by Cao and colleagues [106] in a 20-year longitudinal study focused on the association between marital status of subjects affected by spinal cord injuries and their SWB level. They established that married/partnered participants had the highest SWB levels at the start of the study, but that this decreased with time. The SWB level of the single did not increase for those maintaining that status. In addition, Hughes and Waite [107] investigating marriage's records from older adults noticed that PWB benefits of the remarriage may not be so large as benefits observed at the first marriage and negative effects of past marital disruptions correlate significantly with years later observed health's status worsening and the development of depressive symptoms.

**Education, Income, Residency:** Level of education, income and residency may have significant impact on individuals positive PWB level and general health status. In a systematic literature review by Read and colleagues [108] 71 studies which investigated the effect of different socio-economic factors on subjective health and wellbeing among older people were included. An association between education, adequacy of incomes and self-rated health, which was considered in 32 of 71 studies, was established in 28 out of 32. 7 studies out of 71 investigated an association between self-rated adequacy of income and self-rated health and all of 7 reported the association. In addition, an association between life satisfaction and income, which was examined in 3 out of 71 studies, was established in 2 studies. An association between life satisfaction and education, was considered in 5 out of 71 studies and 3 investigations out of 5 reported the association. There is evidence that high education and high incomes correlate positively with high PWB level and good mental health (e.g. [100, 109, 101, 103]), and even with improving psychological adjustments (e.g. [99]). High personal incomes have an improving effect on adults' PWB level (e.g. [101, 103]) even though adolescents' own perceptions of family's economic positions relate more significantly than the realistic incomes of their families with their mental health status [110].

There are no clear results connecting residency's impact on PWB level. Sun and colleagues [103] investigated associating between residency and SWB for 8,000 Chinese's respondents. They reported that villagers predominantly have higher level of SWB than city residents, independently from their socioeconomic and subjective health status. Nevertheless, Requena [111], which reported data from 56,835 respondents from 29 different countries, observed that villagers have higher SWB level than city residents only in developed, wealthier countries. Garrett and colleagues [112] collected residency's data from 25,963 English adults and reported positive associations between living closer to the coast and respondents' mental health status. City residents living near coastal settings (within a radius of 1 km) have less mental health problems than citizens living more than 50 km away. However, the association was significant only among low-earning respondents, living less than 5 km far from the coast. The World Happiness Report [113], investigating differences on happiness levels of urban and rural residents in 150 countries, supported the conclusions of the above-mentioned studies reporting that, in general, urban residents are showing higher levels of happiness than city residents.

## Psychological PWB Features

Personal psychological characteristics have an impact on our behavioral patterns, decision-makings and individuals' mental wellbeing and PWB level. In the following are discussed psychological features which have been reported to affect PWB level.

**Character Strength:** Character strengths are defined as "personality traits that are positively valued, and represent different routes to the superordinate virtues" [114, p. 1]. Character strengths were introduced by Peterson and Seligman [115] as positive personality traits that can contribute to an individual's good life achievements. 24 character strengths have been identified, among those it is possible to find appreciation of beauty and excellence, hope (optimism), humor (playfulness), spirituality, courage. Höfer and colleagues [114] reported positive correlations among PWB level, mental wellbeing, and character strengths. Hausler and colleagues [116] reported correlations, from high to moderate, of character strengths as hope, zest, gratitude, curiosity and love correlations with PWB and SWB level. Similar correlations were reported by Höfer and colleagues [114] with character strengths such as zest, hope, curiosity and love, and by Wagner and colleagues [117] which reported that perspective, persistence and zest are the best predictors of wellbeing.

Further support of the positive correlations between character strengths use and life satisfaction among undergraduate students were reported by Allan and Duffy [118] and Douglass and Duffy [119]. The first investigation included one more variable which was not examined in studies described above, which is calling. Allan and Duffy [118] defined calling as “careers that are personally meaningful and work toward the greater good” (p. 3). They established that individuals with low in calling and high level of signature strengths (the authors summed participants’ scores for their top 5 character strengths to receive a signature strengths level score, according to the method of Littman-Ovadia [120] demonstrated the significant association between strengths use and life satisfaction. The second investigation also confirmed that increased level of self-esteem in students was partially due to strengths’ use connected with life satisfaction. Additionally, Douglass and Duffy [119] investigated the association between strengths’ use and life satisfaction by studying the potential mediating effect of self-esteem and potential moderating effect of positive affect. The authors concluded that strengths use was associated with elevated levels of life satisfaction.

Other personality traits that may contribute to positive PWB level are individuals’ patterns of behavior, thoughts, and emotions [121]. Saricaoğlu and Arslan [122] found significant positive correlation between all subscales of PWB, according to six-stages Ryff’s model, and self-compassion. The positive correlation between an agreeableness and PWB was identified for 5 PWB subscales except autonomy. Moreira and colleagues [123], while investigating psychobiological model of personality as multidimensional character profiles (self-directedness, cooperativeness and self-transcendence) and wellbeing in adolescents, found that self-directedness was strongly associated with all dimensions of wellbeing, but cooperativeness related to it “only when associated to the elevation of self-directedness and self-transcendence” [123, p. 1]. The researchers concluded that an independent contribution to wellbeing is provided by each character dimension and it depends of the interactions with other dimensions of character and this find for adolescents is consistent with others study results which were focused on adults (e.g. [124, 125]).

## **Biomarkers of PWB**

Physiological features of PWB are: EEG signals, speech patterns, cortisol levels, chronic physical conditions and body mass index.

**EEG Signals:** There is no unanimous consensus on the correlation between EEG signals and PWB level. Klug [126] did not observe relationship between PWB level and frontal alpha wave asymmetry. However, Saeed and colleagues [127] suggested that alpha wave asymmetry (frontal and temporal) can be used as biomarker for stress detecting and classification. Moreover, a support vector machine, based on expert evaluation-based labeling method, is effective for classification of long-term human stress, according the authors’ suggestion. This machine, developed by Saeed and colleagues [127], reached up to 85.20% accuracy. Furthermore, the support vector machine, by Sharma and Chopra [128], has reached up to 90.32% accuracy in stress detection by using alpha waves.

There are data that greater relative right-sided brain activity in the medial-frontal region can be a predictor of depressive symptoms a year after the first data collection. Mitchell and Pössel [129] examined and established this association among boys. However, greater relative right-sided activity in the lateral-frontal was not related to depressive symptoms one year later. Moreover, an association between frontal brain activity at baseline and current symptoms of depression was not established. Demerdzieva [130] investigated EEG brain activity in children with anxiety disorder and concluded that these children have decreased theta, alpha and beta activity, especially in central and midline regions [130]. Additionally, a suggestion that there are a limited number of electrode sites, from which clinicians may get useful data for detecting subjects with MDD, has been made by Cook and colleagues [131]. They established that brain oscillatory activity from the midline prefrontal region relates to changed brain activity in MDD subjects. In a review by Newson and Thiagarajan [132], it was concluded that for depression an increase of absolute power for delta and theta bands for both closed and open eyes condition is typical. For instance, Arns and colleagues [133] demonstrated increased theta power across frontal regions of the brain using the eLORETA source localized signal. However, this study included the largest amount of subjects, comparing with other studies which were included in the review. Moreover, Arns and colleagues [133] used the eLORETA, which is methodologically different from most other studies included in the review. Consequently, those conditions could be a reason of bias of the review results and conclusion. Additionally, in the studies considered in the review, in which researchers failed to find any significant differences across any band, these increases of absolute power were no longer visible (e.g. [131]).

Finally, in many studies, it is noticed that despite accumulated data and evidence that EEG signs are associated with depression and other mental problems, there are inconsistencies in the literature since different researchers use various methodology for investigating (e.g. [134, 135, 132, 136]).

**Speech Patterns:** Speech features investigations are becoming more widespread mental health variable for study. Cummins and colleagues [137] established that both depression and suicidality, which directly have an impact on PWB level, might lead to some cognitive impairments which are reflected in speech. There are acoustic, prosodic and linguistic features of speech which researchers are investigating. Pauses during speech, reduction in articulatory coordination and respiratory rate are acoustic features which have significant correlations with several mental problems. Speaking rate, the pitch, loudness and energy dynamics are prosodic features of it. Using first-person singular pronouns (FPSP), negative emotion words and positive emotion words are linguistic features which can be related to mental health recognition.

Taguchi and colleagues [138] demonstrated that Mel-frequency cepstral coefficients (MFCC), MFCC2 are substantially different by depressed and control group, MFCC2' group contrasts reflected an energy difference in frequency about 2000-3000 Hz. However, in other study by Wang and colleagues [139], which used answers on emotional videos for data collection, established that loudness and other MFCC variables such as MFCC5 and MFCC7 significantly differ between groups, this dissimilarity was significant with no regard of emotions and tasks which were involved.

Prosodic features such as total pause time, pause variability, per cent pause time, speech/pause ratio, and speaking rate was recognized by Mundt and colleagues [140] as significant variables for depression detection and for categorizing the severity of symptoms, natural speech and reading were used for data collection. Additionally, Yang and colleagues [141] also suggested that features of vocal prosody could be a considerable contribution to depression detecting. In the study, which investigated both acoustic and prosodic features, it was established that articulation rate, phonation time, speaking rate, pitch, average absolute deviation of energy and MFCC1,6-10 have statistical significance and are reliable features of speech for depression detection [142]. In this study, researchers asked patients from one of the groups (both groups consisted of depressed participants) to suppress anything that they felt would be indicative of their depression and then analyzed and compressed these data. According to the results, despite concealed participants' behavior the variables remained relatively robust. It indicates good potential for building deception-proof automatic depression monitoring systems, however, small sample was used in the study, only 17 participants.

In the meta-analysis by Tølbøll [143], which included 26 studies, which focused on investigating linguistic features of speech related to depression, an association between all these features and depression was demonstrated. Despite proof of frequent usage of FPSP by depressed persons, the positive relation to it was established from small to medium, hence, this feature can be used as a feature for depression detecting but not for identification of depression levels. The feature such as increased usage of negative emotion words by depressed persons in comparison with control samples was confirmed, however, there is a contradictory classification of the effect sizes (Cohen's  $d = 0.72$  and Pearson's  $r = 0.12$ ) which could have been caused by the possibility of publication bias. The association between decreased usage of positive emotion words and depression was also confirmed. The association was from small to medium (Cohen's  $d = -0.38$  and Pearson's  $r = -0.21$ ). Finally, Tølbøll [143] specified that the variance of results presented in the studies could not be explained by either age or task category and have to further investigation.

**Cortisol:** Cortisol is a biomarker of hypothalamic pituitary adrenal axis functioning. Researchers are investigating cortisol disbalance in blood, saliva, hair strands and urine and alteration of cortisol level during a day or longer periods. There is a number of studies in which association between higher salivary cortisol level in general and depression were established. Besides a conclusion of the association between higher salivary cortisol level and depression, Dienes and colleagues [144] suggested that not only depressed participants demonstrate is higher diurnal cortisol measures but also participants at risk for depression demonstrate similar cortisol results. Subjects with risk of depression also showed significantly higher waking cortisol levels beside with control subjects. However, the response to the laboratory social stressor was different for these two groups. In addition, significantly higher cortisol during the last 3 months was registered in hair strands of participants with mental health problems [145]. In a

review by Staufenbiel and colleagues [146] of 19 studies, it was claimed that in general depression associates with increased hair cortisol, however, anxiety disorders associate with decreased cortisol index. Additionally, concentrations of it increased for bipolar disorder only in patients with a late age of onset. In a review investigating diurnal cortisol slopes by Adam and colleagues [147], the researchers concluded that flatter diurnal cortisol slopes associated with poor mental health in general and with depression and anxiety in particular. However, some other study demonstrated data that only evening salivary cortisol associates with PWB. Stafford and colleagues [148] concluded that every 1 standard deviation increase cortisol in the evening time was associated with a decrease of PWB level on 0.47 point, according to Warwick Edinburgh Mental Wellbeing Scale.

**Chronic Physical Conditions:** There is no uniform definition of chronic physical conditions (CPC), however, most of authors consider CPC as a recurring, lasting condition, and/or physical consequences of the condition [149]. For instance, Conversano [150] defined CPC as a several persisting lifelong heterogeneous conditions which have strong effects on PWB level. Santos and colleagues [151] investigating relations between CPC of adolescents and PWB concluded that CPC have a significant negative effect on adolescents' PWB if it influences school participation. In addition, most of CPC have an association with suicidal ideation in the total sample, according Scott and colleagues [152]. An association between chronic conditions such as epilepsy, cancer, heart attack, stroke and planned suicidal attempts was established. Chronic conditions as heart attack, stroke, high blood pressure, arthritis, respiratory conditions, chronic headache and other chronic pain have association with suicidal attempts. The risk of suicidal outcomes soars with the increasing of CPC numbers, but this increase is not proportionate. The additional risk is smaller with each additional CPC. However, there was established only 1.0-6.5% of the association between the incidence of depression in Taiwanese patients with metabolic syndrome that significantly lower than in western countries [153], hence, there can be regional differences of this association. Acceptance of patients their CPC is another dimension which has an effect on PWB. Verhoof and colleagues [154] investigated an association between feeling of acceptance, anxiety and depression in young adults, who have a disability benefit because of a CPC since childhood. The association was established, more acceptance of CPC is related with less anxiety and depression. Additionally, there is some evidence that mental health problems are able to affect the course of CPC and able to cause sequelae and further complications (e.g. [155]). According to a study of Daré and colleagues [155], there is a 36.6% combined prevalence of mental health problems in CPC patients.

**Body Mass Index:** According to WHO in 2016 more than 1,9 billion adults were overweight, in addition, about 650 million of these were obese.<sup>1</sup> A correlation between body mass index (BMI) and mental health problems was established in many studies, however, an effect of the correlation can vary in different groups (age, gender, health status etc).

In the meta-analysis by de Wit and colleagues [156] which studied the relation between obesity and depression in a total of 204,507 adults, the strong relation was established and was more marked among women. In the systematic review and meta-analysis by Luppino and colleagues [157], which included 15 longitudinal studies, the relation between depression and obesity was re-established. Moreover, a reverse association was also established, depression was found to be a predictor of obesity developing. de Wit and colleagues [158] demonstrated that there is a negative effect of both underweight and obesity (U-shaped association) on men and women mental health, in particular, it leads to depression. However, in a study by Linna and colleagues [159], which include 5240 twins in the investigation, inverse U-shaped association between BMI and SWB was established for men and women with lifetime eating disorder only. It was concluded that optimal BIM verifies from 26.1 to 28.9 kg/m<sup>2</sup>.

## Discussion

Since the last century, there has been a growing interest in investigating PWB. However, there is still a need to establish a universal, independent measure of PWB without any limitations or with minimal limitations. It will allow introducing this measure to healthcare system easily for early detection and preventive treatments of low level of PWB, consequently, it will reduce costs of diagnostics and therapy, as well as improve patients' quality of life. There are many limitations for establishing universal measure,

such as high cost of equipment, its bulkiness, static evaluating, which does not allow to estimate dynamic changing, the unreliability of measurements and reverse output etc. Additionally, Dejonckheere and colleagues [21] reported another important limitation. New measures for detecting and predicting PWB are being investigated, but not all of the researcher's findings convey unique information. The Dejonckheere study, which investigated existing emotion dynamics measures relating to PWB, established that several of these measures have little added value, they are unable to demonstrate independent relations between affect dynamics and PWB. Therefore, researchers should take added value into consideration studying new measures and verify that their findings provide unique information.

In an effort to develop new universal PWB measure, researchers are using different human features for it. We suggest that the features, which were considered in the paper, could be categorized into three groups: affecting features, features for therapy and detection features. We provide a summary table of the classification of works reviewed here below.

№	Number in the references	Article title	Year of article	Features of PWB	Summary	Group of features
1	99.	Subjective and psychological well-being among elderly participants of a University of the Third Age.	2017	Gender and age, Education and income	PWB levels decline with age, with the decline being significantly greater in women than in men. However, these figures vary from region to region. Married participants show higher levels of PWB than single and divorced respondents, however, there is evidence that the correlation between marital status and PWB changes over time. High education and higher incomes correlate positively with high PWB level and good mental health There are no clear results connecting residency's impact on PWB level (villagers/city residents), but residency near coastal may have a positive effect on PWB. These features should be considered in a group due to the close relationship of these features.	Affecting features (the first group)
2	100	Relationship Between Mental Health and the Education Level in Elderly People: Mediation of Leisure Attitude.	2020	Gender and age, Education and income		
3	101.	Demographic Correlates of Psychological Well-Being and Distress Among Older African Americans and Caribbean Black Adults.	2010	Gender and age, Marital status, Residency and income		
4	102.	Changes in psychological well-being among older Lithuanian city dwellers: Results from a cohort study.	2018	Gender and age		
5	103.	Subjective Well-Being and Its Association with Subjective Health Status, Age, Sex, Region, and Socio-economic Characteristics in a Chinese Population Study.	2015	Gender and age, Marital status, Residency, education and income		
6	104.	Does Psychological Well-Being Change with Age?: Longitudinal Tests of Age Variations and Further Exploration of the Multidimensionality of Ryff's Model of Psychological Well-Being.	2011	Gender and age		
7	105.	Family Relationships and Well-Being.	2017	Marital status		
8	106.	Impact of Marital Status on 20-Year Subjective Well-being Trajectories.	2015	Marital status		

9	107.	Marital biography and health at mid-life	2009	Marital status	
10	108.	Socio-economic position and subjective health and well-being among older people in Europe.	2016	Education and income	
11	109.	Formal education level versus self-rated literacy as predictors of cognitive aging.	2012	Education and income	
12	110.	Interplay of subjective and objective economic well-being on the mental health of Norwegian adolescents.	2019	Income	
13	111.	Rural-Urban Living and Level of Economic Development as Factors in Subjective Well-Being.	2016	Residency	
14	112.	Coastal proximity and mental health among urban adults in England: The moderating effect of household income.	2019	Residency and income	
15	113.	World Happiness Report.	2020	Residency	
16	114.	Special Issue: Character Strengths, Well-Being, and Health in Educational and Vocational Settings.	2020	Character strength	Positive correlations from high to moderate, of character strengths and PWB exist (e.g. zest, hope, curiosity, self-compassion).
17	116.	Distinguishing Relational Aspects of Character Strengths with Subjective and Psychological Well-being.	2017	Character strength	
18	117.	Character Strengths and PERMA: Investigating the Relationships of Character Strengths with a Multidimensional Framework of Well-Being.	2019	Character strength	
19	118.	Examining Moderators of Signature Strengths Use and Well-being: Calling and Signature Strengths Level.	2014	Character strength	
20	119.	Strengths Use and Life Satisfaction: A Moderated Mediation Approach.	2014	Character strength	
21	120.	Character strengths and well-being among volunteers and employees: Toward an integrative model.	2010	Character strength	
22	121.	Personality traits and personal values: a meta-analysis.	2015	Character strength	
23	122.	An Investigation into Psychological Well-being Levels of Higher Education Students with Respect to Personality Traits and Self-compassion.	2013	Character strength	
24	123.	Personality and well-being in adolescents.	2014	Character strength	
25	124.	Personality and the perception of health and happiness.	2011	Character strength	

26	125.	Associations of personality profiles with various aspects of well-being: a population-based study.	2011	Character strength		
27	144.	Cortisol secretion in depressed, and at-risk adults.	2013	Cortisol		
28	145.	-term increased cortisol levels in young people with mental health problems.	2016	Cortisol	Subjects with depression or risk of depression show higher waking cortisol levels beside with control subjects. Anxiety disorders associate with decreased cortisol index. The time (morning, afternoon, evening) when materials (e g salivary) were taken is important.	
29	146.	Hair cortisol, stress exposure, and mental health in humans: a systematic review.	2013	Cortisol		
30	147.	Diurnal cortisol slopes and mental and physical health outcomes: A systematic review and meta-analysis.	2017	Cortisol		
31	148.	Diurnal cortisol and mental well-being in middle and older age: evidence from four cohort studies.	2017	Cortisol		
32	149.	Chronic Physical Health Conditions and Emotional Problems From Early Adolescence Through Midadolescence.	2017	Chronic physical condition		
33	150.	Common Psychological Factors in Chronic Diseases.	2019	Chronic physical condition	Chronic physical condition have a significant negative effect on PWB under some additional conditions.	
34	151.	Psychological well-being and chronic condition in Portuguese adolescents.	2015	Chronic physical condition		
35	152.	Chronic physical conditions and their association with first onset of suicidal behavior in the world mental health surveys.	2010	Chronic physical condition		
36	153.	Rapid Screening of Psychological Well-Being of Patients with Chronic Illness: Reliability and Validity Test on WHO-5 and PHQ-9 Scales.	2014	Chronic physical condition		
37	154.	Psychosocial well-being in young adults with chronic illness since childhood: the role of illness cognitions.	2014	Chronic physical condition		
38	155.	Co-morbidities of mental disorders and chronic physical diseases in developing and emerging countries: a meta-analysis.	2019	Chronic physical condition		
39	25.	Cross-Sectional and Longitudinal Associations between Leisure Time Physical Activity, Mental Well-Being and Subjective Health in Middle Adulthood.	2019	Physical activity		
40	26.	The Relationship between the Physical Activity Environment, Nature Relatedness, Anxiety, and the Psychological Well-being Benefits of Regular Exercisers.	2017	Physical activity		

41	27.	Get Active? A Meta-Analysis of Leisure-Time Physical Activity and Subjective Well-Being.	2017	Physical activity	Different types of physical activity have a good impact on PWB. The factors that affect to degree of positive impact are environment where activity taking and frequency of physical activities.	Features for therapy (the second group)
42	28.	Mental Health Benefits of Strength Training in Adults.	2010	Physical activity		
43	29.	Adolescent girls physical activity, fitness and psychological well-being during a health club physical education approach.	2016	Physical activity		
44	30.	Participation in a 9-month selected physical exercise program enhances psychological well-being in a prison population.	2015	Physical activity		
45	31.	Effects of a high-intensity functional exercise program on depressive symptoms and psychological well-being among older people living in residential care facilities: A cluster-randomized controlled trial.	2010	Physical activity		
46	32.	Liver enzymes and psychological well-being response to aerobic exercise training in patients with chronic hepatitis C.	2014	Physical activity		
47	33.	Acute effects of outdoor physical activity on affect and psychological well-being in depressed patients-A preliminary study.	2016	Physical activity		
48	34.	Exploring the effect of aquatic exercise on behaviour and psychological well-being in people with moderate to severe dementia: a pilot study of the Watermemories Swimming Club.	2014	Physical activity		
49	35.	The relationship between physical activity and mental health varies across activity intensity levels and dimensions of mental health among women and men.	2010	Physical activity		
50	36.	Sport participation and stress among women and men.	2012	Physical activity		
51	37.	Changes in leisure-time physical activity and physical and mental health functioning: a follow-up study.	2017	Physical activity		
52	38.	Physical activity intensity and subjective well-being in healthy adults.	2019	Physical activity		
53	39.	Volume and social context of physical activity in association with mental health, anxiety and depression among youth.	2016	Physical activity		
54	40.	The social and psychological health outcomes of team sport participation in adults: An integrative review of research.	2019	Physical activity		

55	41.	Leisure time physical activity and subsequent physical and mental health functioning among midlife Finnish, British and Japanese employees: a follow-up study in three occupational cohorts.	2016	Physical activity	
56	42.	Bidirectional association between mental health and physical activity in older adults: Whitehall II prospective cohort study.	2014	Physical activity	
57	43.	Sleep and Wellbeing, Now and in the Future.	2020	Sleep pattern	
58	44.	Short Sleep Duration and Insomnia Symptoms were Associated with Lower Happiness Levels in Chinese Adults in Hong Kong.	2019	Sleep pattern	<p>Not only both insomnia and hypersomnia have a negative effect on PWB, but bedtime (time person go to bed) also important factor that influence on PWB level.</p> <p>People suffer from depression and anxiety may experience changes in their sleep phases.</p>
59	45.	Psychiatric disorders and sleep.	2012	Sleep pattern	
60	46.	The Role of Sleep Quality in the Psychological Well-Being of Final Year Undergraduate Students in China.	2018	Sleep pattern	
61	47.	Depression in sleep disturbance: A review on a bidirectional relationship, mechanisms and treatment.	2019	Sleep pattern	
62	48.	Relapse insomnia increases greater risk of anxiety and depression: evidence from a population-based 4-year cohort study.	2017	Sleep pattern	
63	49.	Stress and sleep reactivity: a prospective investigation of the stress-diathesis model of insomnia.	2014	Sleep pattern	
64	50.	The bidirectional association between depression and insomnia: the HUNT study.	2012	Sleep pattern	
65	51.	Longitudinal course of depression scores with and without insomnia in non-depressed individuals: a 6-year follow-up longitudinal study in a Korean cohort.	2013	Sleep pattern	
66	52.	Insomnia as a risk factor for ill health: Results from the large population-based prospective HUNT Study in Norway.	2013	Sleep pattern	
67	53.	Hypersomnia and depressive symptoms: methodological and clinical aspects.	2013	Sleep pattern	
68	54.	Sleep electroencephalography as a biomarker in depression.	2015	Sleep pattern	
69	55.	Sleep Patterns and Mental Health Correlates in US Adolescents.	2017	Sleep pattern	

70	56.	Sleep and mental disorders: A meta-analysis of polysomnographic research.	2016	Sleep pattern	High level of perceived emotional support have a positive effect, while low level are linked to the onset or presence of depression. Receiving emotional support and/or perceiving negative interactions either both from family members and friends have an effect. Large established social networks prevent from being affected by depression. Furthermore, a combination and the quality of the network are important. Mental condition (e.g. depression) of friends and neighbors affect too.  Using Facebook for maintaining real-life friendships has a positive effect, while using it for establishing new connections (e.g. making new friends) is associated with negative effects.
71	57.	Sleep disturbance in mental health problems and neurodegenerative disease.	2013	Sleep pattern	
72	73.	The association between social relationships and depression: a systematic review.	2015	Social interaction	
73	74.	Living arrangements, social networks and depressive symptoms among older men and women in Singapore.	2011	Social interaction	
74	75.	Assessing social support and depressive symptoms in older Chinese adults: a longitudinal perspective.	2011	Social interaction	
75	76.	Late-life depressive symptoms: prediction models of change.	2013	Social interaction	
76	77.	Trajectory classes of depressive symptoms in a community sample of older adults.	2012	Social interaction	
77	78.	The association between social network relationships and depressive symptoms among older Americans: what matters most?	2011	Social interaction	
78	79.	Physical activity, social network type, and depressive symptoms in late life: an analysis of data from the National Social Life, Health and Aging Project.	2012	Social interaction	
79	80.	Gender differences in the relation between depression and social support in later life.	2013	Social interaction	
80	81.	Depression and social networks in community dwelling elders: a descriptive study.	2011	Social interaction	
81	82.	Social network determinants of depression.	2011	Social interaction	
82	83.	Perceived social isolation makes me sad: 5-year cross-lagged analyses of loneliness and depressive symptomatology in the Chicago Health, Aging, and Social Relations Study.	2010	Social interaction	
83	84.	Relationship between Facebook Use and Psychological Well-being for Baccalaureate Nursing Students at Benha University.	2018	Social interaction	
84	85.	Relationship of internet use and psychological well-being among students in Princess Nourah university.	2016	Social interaction	
85	86.	Problematic Internet use and associated risks in a college sample.	2013	Social interaction	

86	87.	Costs and Benefits of Facebook for Undergraduate Students. Interdisciplinary Journal of Information, Knowledge, and Management.	2012	Social interaction	
87	88.	The Facebook Paradox: Effects of Facebooking on Individuals' Social Relationships and Psychological Well-Being.	2017	Social interaction	
88	89.	Do motivations for using Facebook moderate the association between Facebook use and psychological well-being?	2015	Social interaction	
89	90.	The Interaction Between Culture, Health and Psychological Well-Being: Data Mining from the Italian Culture and Well-Being Project.	2011	Creating activities	
90	91.	The art of being mentally healthy: a study to quantify the relationship between recreational arts engagement and mental well-being in the general population.	2016	Creating activities	Creating activities (e.g. doing art, visiting museum, galleries) can improve health and PWB level in both clinical and non-clinical group, 100 hours/year or more of doing it have a significant positive effect on PWB.
91	92.	Museum-based programs for socially isolated older adults: Understanding what works.	2017	Creating activities	
92	93.	Effects of a museum-based social prescription intervention on quantitative measures of psychological wellbeing in older adults.	2018	Creating activities	
93	94.	The Arts in Psychotherapy The art-gallery as a resource for recovery for people who have experienced psychosis.	2013	Creating activities	
94	95.	The therapeutic effectiveness of creative activities on mental well-being: a systematic review of the literature.	2011	Creating activities	
95	96.	Empathy, Einfühlung, and aesthetic experience: the effect of emotion contagion on appreciation of representational and abstract art using fEMG and SCR.	2018	Creating activities	
96	97.	Art and Psychological Well-Being: Linking the Brain to the Aesthetic Emotion.	2019	Creating activities	
97	98.	The Distancing-Embracing model of the enjoyment of negative emotions in art reception.	2017	Creating activities	
98	156.	Depression and obesity: a meta-analysis of community-based studies.	2010	Body mass index	

99	157.	Overweight, obesity, and depression: a systematic review and meta-analysis of longitudinal studies.	2010	Body mass index	Obesity and underweight associated with depression and low PWB levels, its correlation is more marked among women.	Detecting features	
100	158.	Depression and body mass index, a u-shaped association.	2009	Body mass index			
101	159.	Body mass index and subjective well-being in young adults: a twin population study.	2013	Body mass index			
102	58.	Emotional expression in psychiatric conditions: New technology for clinicians.	2019	Body language			
103	59.	Body language in the brain: constructing meaning from expressive movement.	2015	Body language	There are several body movements that were detected as a feature of depressed people (e.g. increased head flexion and thoracic kyphosis). However, context in which gestures are made should carefully be consider by researchers.		
104	60.	Nonverbal communication in psychotherapy.	2010	Body language			
105	61.	Recognition of emotion from body language among patients with unipolar depression.	2013	Body language			
106	62.	Posture and body image in individuals with major depressive disorder: a controlled study.	2010	Body language			
107	63.	Associating Facial Expressions and Upper-Body Gestures with Learning Tasks for Enhancing Intelligent Tutoring Systems.	2020	Facial expression			
108	64.	Can Body Expressions Contribute to Automatic Depression Analysis?	2013	Facial expression			
109	65.	More than a face: a unified theoretical perspective on nonverbal social cue processing in social anxiety.	2013	Facial expression			Consideration at the same time both facial expression and body improve accuracy of detection.
110	66.	The time course of attentional disengagement from angry faces in social anxiety.	2011	Facial expression			
111	67.	Social anxiety and difficulty disengaging threat: evidence from eye-tracking.	2012	Facial expression			
112	68.	Virtual social interactions in social anxiety--the impact of sex, gaze, and interpersonal distance.	2010	Facial expression			
113	69.	Social Risk and Depression: Evidence from Manual and Automatic Facial Expression Analysis.	2013	Facial expression			
114	70.	Jumping for Joy: The Importance of the Body and of Dynamics in the Expression and Recognition of Positive Emotions.	2018	Facial expression			
115	71.	Functional Smiles: Tools for Love, Sympathy, and War.	2017	Facial expression			
116	72.	The different faces of fear and threat. Evolutionary and cultural insights.	2018	Facial expression	Decrease in facial activity s related to depression and also there is a reverse effect.		
					Facial dynamics provide more information than using static facial expression information only.		

117	126.	The Relationship Between Resting Frontal EEG Asymmetry and Mental Well-Being.	2016	EEG signals	
118	127.	EEG based Classification of Long-term Stress Using Psychological Labeling.	2020	EEG signals	Alpha wave asymmetry (frontal and temporal) may be used as biomarker for stress detecting and classification. Decreased theta, alpha and beta activity activity, especially in central and midline regions related to anxiety disorder among children. There is an increase of absolute power for delta and theta bands (closed/open eyes) among depressed subjects. Despite accumulated data, there are inconsistencies in the literature since different researchers use various methodology for investigating.
119	128.	EEG signal analysis and detection of stress using classification techniques.	2020	EEG signals	
120	129.	Frontal brain activity pattern predicts depression in adolescent boys.	2012	EEG signals	
121	130.	EEG Characteristics of Generalized Anxiety Disorder in Childhood.	2011	EEG signals	
122	131.	Do prefrontal midline electrodes provide unique neurophysiologic information in Major Depressive Disorder?	2014	EEG signals	
123	132.	EEG Frequency Bands in Psychiatric Disorders: A Review of Resting State Studies.	2019	EEG signals	
124	133.	Frontal and rostral anterior cingulate (rACC) theta EEG in depression: implications for treatment outcome?	2015	EEG signals	
125	134.	Frontal EEG Asymmetry as a Promising Marker of Depression Vulnerability: Summary and Methodological Considerations.	2015	EEG signals	
126	135.	Electroencephalogram alpha asymmetry in patients with depressive disorders: current perspectives.	2018	EEG signals	
127	136.	Frontal alpha asymmetry as a diagnostic marker in depression: Fact or fiction?	2017	EEG signals	
128	137.	A review of depression and suicide risk assessment using speech analysis.	2015	Speech patterns	There are substantially different by depressed and control group in MFCC1-2, MFCC5-10.Total pause time, pause variability, per cent pause time, speech/pause ratio, and speaking rate was recognized as significant variables for depression detection and for categorizing the severity of symptoms. Increased usage of negative emotion words and decreased usage of positive emotion words related to depression.
129	138.	Major depressive disorder discrimination using vocal acoustic features.	2018	Speech patterns	
130	139.	Acoustic differences between healthy and depressed people: a cross-situation study.	2019	Speech patterns	
131	140.	Vocal acoustic biomarkers of depression severity and treatment response.	2012	Speech patterns	
132	141.	Detecting Depression Severity from Vocal Prosody.	2013	Speech patterns	
133	142.	Objective Methods for Reliable Detection of Concealed Depression.	2015	Speech patterns	
134	143.	Linguistic features in depression: a meta-analysis.	2019	Speech patterns	

The first group includes features which affect PWB and are not likely to be changed. The features of this group are considered by us as factual, which contribute to PWB level, but could not be used as a main feature of PWB level detection. We suggest that an age, gender, marital status, personal's characteristic, education, income, cortisol, residency, chronic physical conditions could be included to the first group. Interactions among these features have also been noted, for example, some effects of marital status may depend on the culture in which the measurements are made (and this has a residency element).

In the second group we classify features which could be improved relatively easy by people by means of exercising persistent conscious intervention. Consequently, therapists, based on these features, could develop therapy for improving patient's PWB level. Physical activity, sleep patterns, body mass, creative activities, social interaction are the PWB features of the second group. For instance, according to results of Zhang and colleagues [55], later bedtime and sleep of less than 7 hours have a negative effect on PWB, hence earlier bedtime (before 22:30) and sleep of more than 7 hours may be used as a therapist's recommendation for a patient with a decreased PWB level. A therapist can also recommend patients to reduce communication with friends and neighbors who have been diagnosed with depression, according results of a study by Rosenquist and colleagues [82]. In addition, nutrition changes to achieve the optimal BMI from 26.1 to 28.9kg/m<sup>2</sup> could be recommended by therapists [159].

Detecting features are ones which, as we suggest, could be used as reliable measures for detecting PWB level. We classified EEG signals, speech patterns, body language and facial expression in the third group. According to our knowledge, there are not a lot of studies which investigate these features as specific PWB measures i.e. measures which detect PWB level considering all PWB dimensions, not only absence of depression, anxiety etc. Therefore, this gap has to be investigated in the further studies. While one may decide to exercise or diet, with exercise having an impact upon EEG signals, most people have little direct conscious control over their EEG signals. Thus, detection features are distinct from therapeutic features.

We think that EEG signals and speech patterns are more promising features for PWB level detection than other features from the third group. One of the reasons is that these features hardly can be controlled by a person (there is no way to hide symptoms) hence it makes that features more reliable than body language and facial expression. EEG is one of the most common sources of information for studying brain function. It allows investigating psychological disorders and emotions. This method is simple, safe, non-invasive, low-cost and also relatively comfortable for participants. Moreover, EEG is lightweight, it can be wireless, and it is becoming more increasingly tolerant to head and body movements, even allowing participants to walk freely. In addition, many medical institutions already have EEG equipment. Based on the above, if relationship between EEG signs and PWB will be clearly established, EEG can widespread be used as a PWB measure at clinic practices in perspective. However, speech patterns have the list of important advantages over EEG signals. Data collection for these pattern investigations can be in the background, in a natural setting by apps for smartphones. It could allow solving several limitations related to patients' trying to hide symptoms and could allow to introduce speech patterns application for PWB detection worldwide. In addition, according to the fact that these features will be detected by smartphone, it enables reduced money and time expenses, since there is no need to buy equipment and visit a laboratory and spend time in there for data collection. Investigation of these features of PWB, EEG signs and speech patterns could allow to spread PWB detection widely with fewer restrictions and not only detect it but also predict.

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## **Conflicts of Interest**

The authors individually and jointly declare that there is no conflict of interest.

## **Author Contributions**

Olga Sheveleva: Data Curation, Investigation, Writing-Original Draft, Gennaro Cordasco: Conceptualization, Supervision, Writing-Review and Editing, Carl Vogel: Conceptualization, Writing-Review and Editing, Anna Esposito: Funding acquisition, Conceptualization, Supervision, Writing-Review and Editing.

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