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„The long-term effect of Physical Exercise on Well-Being“

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Acknowledgement

The writing of this Thesis was a part of a long and painful process of learning, which is not necessarily reflected on the words, sentences and ideas which compose it.

To K.

I want to thank to Ass.-Prof. Mgr. Dr. Peter Gröpel for his supervision, feedback, and patience.

The data used in this master thesis were collected as part of a broader research project on longitudinal gym attendance by Philipp M. Kopp (Technical University of Munich, Germany) and provided to me by Philipp M. Kopp and Peter Gröpel (University of Vienna) for analysis. Philipp M. Kopp is a PhD student co-mentored by Peter Gröpel, and the data set used in this thesis was also used by Kopp, Senner, and Gröpel (2020). In particular, Kopp et al. tested volitional competencies as predictors of gym attendance. Participants' well-being was also measured, but not yet analyzed.

Abstract

According to the hedonic adaptation model, humans quickly adapt to good and bad events in their lives, keeping a relatively constant level of happiness. Consequently, trying to become happier may be as futile as trying to become taller (Lykken & Tellegen, 1996) and the efforts set for failure. Nevertheless, as subjective well-being (SWB) emerges from a combination of genetics, behavioral and circumstantial factors, its immutability over longer periods of time has become less clear.

Therefore, the aim of the present study is to explore the long-term effects of physical exercise on SWB. For this purpose, I conducted an analysis on a study with a prospective and longitudinal design and a sample size of 324 participants.

The SWB and the gym attendance of the participants were measured on four different occasions over 30 weeks. The World Health Organization 5-item Well-Being Index (WHO-5) was used for measuring the SWB, while gym attendance was self-reported in exercising days per week.
Supporting previous research (Reed & Buck, 2009), evidence was found for exercise effectively raising the SWB of the individuals, showing a stronger relationship with lower levels of SWB.

Furthermore, exercise seems to play an important role in the maintenance of SWB. Consequently, the later decrease in exercise was moderated by the decrease in SWB. The more the participants reduced exercise, the more the SWB declined.

Exercise seems to be connected not only to the raising in SWB, as well as in maintaining the levels of SWB.

The results of the present research offers hope for those aiming to decrease human misery and increase happiness.

Keywords: subjective well-being, exercise, SWB, long-term effects, gym attendance.

Abstrakt

Laut des Modells der Hedonistischen Tretmühle, passt sich der Mensch schnell an gute und schlechte Ereignisse in seinem Leben an und hält sein Glücksniveau auf einem relativ konstantem Level. Folglich kann der Versuch glücklicher zu werden, genauso vergeblich sein, wie der Versuch zu wachsen (Lykken & Tellegen, 1996) und die entsprechenden Bemühungen sind zum Scheitern verurteilt. Da sich das subjektive Wohlbefinden (SWB) jedoch aus einer Kombination von genetischen, verhaltensbezogenen und umstandsbedingten Faktoren ergibt, ist seine Unveränderlichkeit über längere Zeiträume weniger klar ersichtlich.

Daher ist das Ziel der vorliegenden Studie, die langfristigen Auswirkungen von körperlicher Bewegung auf das SWB zu untersuchen. Zu diesem Zweck wurde eine Studie mit einem prospektiven und longitudinalen Design und einer Stichprobengröße von 324 Teilnehmern analysiert.

Das SWB und die Fitnessstudiobesuche der Teilnehmer wurden an vier verschiedenen Zeitpunkten über 30 Wochen gemessen. Der 5-Elemente-Wohlbefinds-Index der Weltgesundheitsorganisation (WHO-5) wurde für die Messung des SWB verwendet, während die Besuche im Fitnessstudio in Trainingstagen pro Woche selbst berichtet wurden. In Übereinstimmung mit früheren Forschungsergebnissen (Reed & Buck, 2009) konnte nachgewiesen werden, dass körperliche Betätigung das subjektive Wohlbefinden der Probanden effektiv steigert, wobei ein stärkerer Zusammenhang mit niedrigeren Ausgangswerten des SWB bestand.

Darüber hinaus scheint Bewegung eine wichtige Rolle bei der Aufrechterhaltung des SWB zu spielen. Folglich wurde die spätere Reduzierung der Bewegung durch die Abnahme des SWB moderiert. Je mehr die Teilnehmer die Bewegung reduzierten, desto mehr nahm das SWB ab.

Bewegung scheint nicht nur mit der Erhöhung des SWB in Verbindung zu stehen, sondern auch mit der Aufrechterhaltung des konstanten Niveaus des SWB.
Die Ergebnisse der vorliegenden Untersuchung bieten Hoffnung für diejenigen, die das menschliche Elend verringern und das Glück erhöhen wollen.

Schlüsselwörter: subjektives Wohlbefinden, Bewegung, SWB, Langzeiteffekte, Fitnessstudiobesuch, WHO-5.

On May 27, 1995, Christopher Reeve's horse started to jump the third fence in an equestrian competition in Virginia, USA, when suddenly stopped without any warning to its rider. Some people reported a rabbit that ran and scared the horse, some people said it was the shadow. Reeve tried to hold himself from the bridle, but his hands got entangled, leaving him unable to break the fall. He flipped over the fence and landed head first. The helmet prevented any brain damage, but the impact shattered his first and second cervical vertebrae, leaving the skull unattached to his spine. The immediate medical help and several weeks in intensive care, saved his life; but the spinal cord injury left him with a paralysis from the shoulders down and unable to breath without a ventilator (Reeve, 1999).

Passing a time of intense grief, the once *Superman* on the big screen, gradually managed to reshape his life. He started to write books, direct films, and give speeches; and soon became an advocate for people with disabilities, raising millions of dollars for research. He still considered himself a lucky guy (Reeve, 1999).

Happiness fluctuates accordingly to the good and bad circumstances taking place in life. Nonetheless, even under extreme circumstances like above described, the individuals tend to adapt over time, returning towards their former level of happiness (Diener, 2001); readjusting their expectations and desires (Armenta, Ruberton, & Lyubomirsky, 2015). This adaptation may be a benefit when negative events take place, but at the same time, an obstacle in the pursuit of happiness (Lyubomirsky, 2010). In the same way, when individuals accustom themselves to positive events, the increase of happiness eventually fades out.

In the search for increases in the level of happiness, regular physical exercise has been found to have a consistent association with subjective well-being (e.g. Reed & Ones, 2006; Reed & Buck, 2009). Even though it is accessible to almost every human, much less people than expected perform exercise on a regular basis. It is free, it is healthy, and it (may) make humans happier; why does not everybody enjoys the benefits of exercise? In Germany, for example, more than 40% of the population do not take part in sports or physical exercise on a weekly basis. Further data shows, that within the people with *very easy* access to green areas, only 49% engage *at least once a week* in physical exercise (Eurofound, 2017).

Thus, the attempt of the present thesis is to answer to the following question:

Are there long-term effects of regular physical exercise on the subjective well-being of the individual?

1.1 Subjective Well-Being and Happiness

It is the greatest happiness of the greatest number that is the measure of right and wrong.

Jeremy Bentham (1748-1832)

Subjective well-being (SWB) is the scientific name for happiness (Diener, 2021), and it is commonly defined as the self-reported evaluation of the quality of one's life (Diener, 2001). Its study developed in part, as a reaction to the vast historic emphasis the field of psychology had put on negative states (Myers & Diener, 1995). For the purpose of the present study, SWB and happiness are used as synonyms.

The global category of happiness is composed of separable well-being variables, each of which show independent variations over time. The hierarchical model of happiness (Diener, Scollon, & Lucas, 2003) describes four components of SWB:

- *Pleasant emotions:* joy, contentment, happy, love, etc.
- *Unpleasant emotions:* sadness, anger, stress, worry, etc.
- *Global Life Judgements:* life satisfaction, meaning, success, fulfillment, etc.
- *Domain Satisfaction:* health, work, relationships, leisure, etc.

Happiness, therefore, can not alone be explained by the presence of pleasant emotions, neither by the absence of unpleasant ones (Kahneman & Deaton, 2010), rather by their interaction in a matrix of meaning and worthwhileness created by the individual and its society.

There are three factors which determine the long-term levels of happiness to different degrees:

- *Genetics.* (50-70%) Very similar levels of SWB were found in studies with identical twins (those sharing the same genetic constitution), no matter if they were raised together or apart. This similarity is not observed in non-identical twins (Tellegen et al., 1988).
- *Intentional activities.* (15-40%). Behavioral and cognitive activities that the individual engages in. Unlike the other two categories, there is a degree of effort required. Some behaviors, such as enhancing in regular exercise, are associated with higher levels of SWB (e.g. Klaperski, Koch, Hewel, Schempp, & Müller, 2019)

- *Life circumstances.* (10%) Wealth, health, occupation, culture, education, etc.

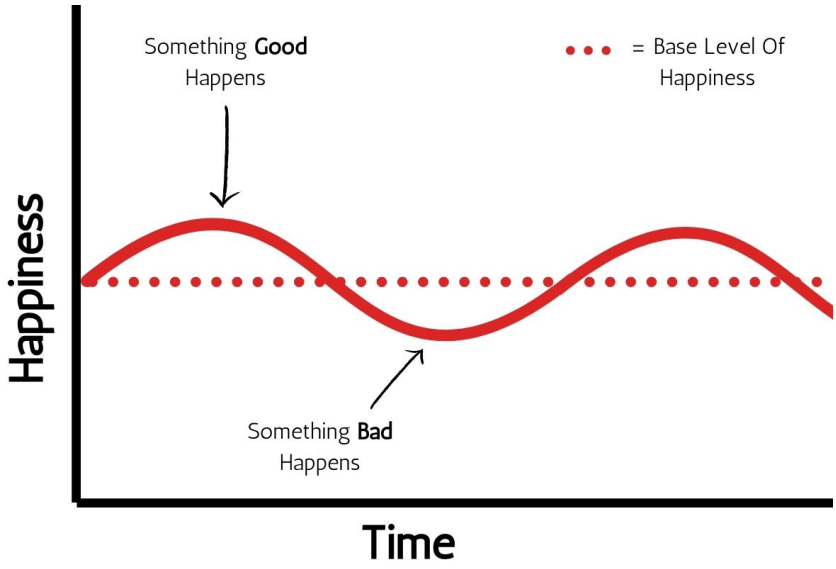
The distinct key point between the last two categories is that circumstances *happen* to people, while activities are ways people *act* to the circumstances (Lyubomirsky, Sheldon, Schkade, 2005). The variance of each category has been a topic of controversy in the scientific field. Furthermore, these three factors influence and interact with one another (Lyubomirsky, 2010). For example, the gene named SCL6A4, which has been implicated in susceptibility to depression, may only be expressed under the right environmental conditions, such as stress (Beversdorf et al., 2018).

The state of mind of the individual determines its happiness more than external events do. For instance, the feeling of success, when getting a salary raise, may result in a temporary feeling of elation; while accidents and injuries may get the person into a period of depression. Nevertheless, sooner or later, the overall level of happiness tends to move back to a certain baseline (The Dalai Lama & Cutler, 1999). This tendency of humans to adapt to external circumstances and to remain in a relatively stable level of happiness is called *The Hedonic Adaptation* (Brickman & Campbell, 1971); and it is not only limited to trivial everyday events, but remains as well under more severe conditions of success and catastrophe (The Dalai Lama & Cutler, 1999). An example of this was given by Brickman, Coates, and Janoff-Bulman (1978), when they concluded that lottery winners were not happier than non-winners, and that people with paraplegia were not substantially less happy than those with a full body functionality.

Different processes similar to sensory adaptation take place when people experience emotional reactions to events, adjusting to the new life circumstances (Brickman & Campbell, 1971). This adaptation has a hedonic set point, a baseline level of happiness, to which individuals adapt in the long-term, independently of the external factors raising and decreasing the SWB in the short-term (*see Graphic 1*).

The idea of hedonic adaptation offers an answer to the observation that people appear to be relatively stable in their level of happiness despite changes in fortune. In addition, it explains the observation that people with substantial resources are not necessarily happier than those with few resources (Diener, Lucas, & Scollon, 2006). Nonetheless, there is a correlation between SWB and economic resources, and there are

substantial differences in the level of happiness between the top income quartile and the low income quartile of the population of Europe (Eurofound, 2017). For example, between 2007 and 2011, in line with the global economic crisis, a decrease of happiness was reported in those countries most affected by the recession (Eurofound, 2012). Money has little effect on SWB, but only after the basic needs of the individual are covered (Eurofound, 2017).



Graphic 1. The Hedonic Adaptation (Brickman & Campbell, 1971).

The relatively small impact of life circumstances on SWB may be caused by the already explained phenomenon of hedonic adaptation, where people experience boosts in their SWB following positive life events and declines after negative ones, but these shifts in SWB do not last and individuals become accustomed to the changes in their lives (Diener et al., 2006). When a positive event takes place, the SWB increases as well as the expectations of the individual. For example, the person who drives one hour to work everyday, will probably be thrilled about the construction of a new highway which reduces the trip by half. After a period of adaptation to the new circumstances, the individual will expect to drive only half an hour. When more drivers start taking the new road and the driving time increases to 45 minutes due to traffic, the person will need to readapt the expectations once more, while presumably experiencing negative emotions.

Happiness, from this perspective, depends on the interaction between objective conditions and subjective expectations (Harari, 2015). However, it must be noted that

individuals do not completely adapt to all life circumstances (Diener, 2001), and the repeated experience of positive affect is a key feature in the improvement and maintenance of SWB (Lyubomirsky et al., 2005).

From a biochemical perspective, SWB is not determined by external parameters like better interpersonal relationships, higher salaries or fair social rights; rather by a complex system of nerves, hormones, neurons, synapses and biochemical messengers such as dopamine, serotonin and oxytocin interacting with one another (Harari, 2015). Around 100 billion neurons in the human brain use chemical substances called neurotransmitters to send messages across a synapse; to target cells like another neurons, muscle cells, or gland cells. The coexistence of several neurotransmitters at the same time in the synapse allows neurons to exert several influences at the same time (Cowen & Browning, 2015). Serotonin, dopamine, oxytocin have been referred as “happy hormones” because of their role in pleasure, happiness, sex, trust, pain and love.

Serotonin is associated with mood regulation, happiness and anxiety; and when in low levels, it can be linked to depression and emotional disorders (Cowen & Browning, 2015). Oxytocin is associated with love, empathy, trust and relationship-building. Dopamine plays a major role in the motivational component of the reward system, increasing its activity on the brain in relation to the thrill of anticipation, and giving to the individual a feeling of crave. The activity of dopamine is high, when the rewards are unexpected, but when the rewards are expected, the excitement decreases alongside with its activity in the brain (the molecule of pleasure). Rats in laboratories, have shown to increase their dopamine activity in the brain when they receive food. Nevertheless, when the rats get used to being fed, their dopamine effect shuts down (Wise, 2006). This same principle, for example, can be applied to humans and materialism; as many people expect money and possessions to bring them happiness for a long time, while it generally brings them only a little happiness and for a very short time (Lyubomirsky, 2010).

Being satisfied with what one has is more important for happiness than getting more of what one may want. Nevertheless, also the internal biochemical system seems to be programmed to keep happiness levels relatively constant (Harari, 2015).

1.2 Physical Exercise and Subjective Well-Being

Orandum est ut sit mens sana in corpore sano.

Juvenal (around 2nd century AD)

The most important predictor of SWB is the *self-perceived level of health* (Eurofound, 2017), which in addition, has a positive correlation with exercising. (Klaperski et al., 2019). Furthermore, the amount of exercise during early adulthood is a predictor of cognitive performance in later stages of life (Dik, Deeg, Visser, & Jonker, 2003).

Exercise is a type of physical activity, consisting of planned, structured and repetitive bodily movements, generally aimed to improve or maintain one or more components of the physical fitness (e.g. body composition, muscular strength, muscular endurance, agility, etc.) (Caspersen, Powell, & Christenson, 1985). Physical exercise of various intensities and durations, when performed on a regular basis, can increase the cognitive capacities of human beings (Cotman & Berchtold, 2002); as well as decrease the risk of chronic diseases like obesity, coronary heart disease, hypertension, and type 2 diabetes along with several others (e.g. Atlantis, Chow, Kirby, & Singh, 2004). Additionally, non-exercisers are more likely to develop emotional disorders in their lifetime than exercisers (Harvey et al., 2017). This corresponds with a study from Klaperski et al. (2019), where exercise leads to mood improvements and reductions of stress and anxiety. Likewise, exercise has been identified as a self-selected coping strategy for managing stress (Cairney, Kwan, Veldhuizen, & Faulkner, 2014). Furthermore, the self-selection of exercise intensity is a moderator which tends to increase the likelihood of the “feeling-better” effect (Ekkekakis, Parfitt, & Petruzzello, 2011, as cited in Bernstein & McNally, 2018).

There is considerable evidence showing that engagement in regular physical exercise improves physical as well as mental health (e.g. Malekshahi, Abdoli, Asefirad, & Mohammadi, 2011; Atlantis, Chow, Kirby, & Singh, 2004; Byrne & Byrne, 1993). It is associated with greater emotional well-being, less severe symptoms of depression and lower anxiety (Helgadóttir, Forsell, Hallgren, Möller, & Ekblom, 2017; DiLorenzo et al., 1999). Nevertheless, it is curious and yet to be explained that even though the population in Germany taking part in sports or physical exercise “*at least once a week”* increased from 48% to 56% between 2011 and 2016, the SWB remained stable (Eurofound, 2012;

Eurofound 2017). This speaks for a multifactoriality behind SWB and for other aspects of regular exercise, such as frequency or intensity that might have different impacts depending on the individual. It is important to account related to exercise research, that there is a significant variability in the findings due to differences in the exercise regimen and the cognitive assessment (Kramer, Colcombe, McAuley, Scalf, & Erickson, 2005).

Nonetheless, individuals who exercise, do not necessarily have less intense and/or less frequent negative emotions, but may be able to recover better from them when they arise (Bernstein & McNally, 2018). Correspondingly, it has been seen that more active individuals reported better coping abilities with stressors and negative mood, than less active ones (Kishida & Elavsky, 2015). Therefore, exercise might not be altering the propensity of negative emotions, but reducing the duration and intensity of the bouts (Bernstein & McNally, 2018). As a result, exercise appears to facilitate the emotional recovery, rather than preventing initial negative emotional responses (Bernstein & McNally, 2016). Moreover, while exercise might be improving the resilience of the individuals, resilience has a positive correlation with SWB (Eurofound, 2017).

The beneficial effects of exercise on brain function have been demonstrated in animal models as well as in a growing number of clinical studies on humans. Variations in the DNA sequence in dopamine receptor genes are related to physical activity levels (Simonen et al, 2003, as cited in Reed & Ones, 2006). Nevertheless, as the beneficial effects of exercise on mental health arise from a dynamic interaction between neurobiological, physical, cognitive and psychosocial factors (Hopkins, Davis, VanTieghem, Whalen, & Bucci, 2012), it is still relatively unclear which psychological processes account for this relationship (Bernstein & McNally, 2018; Scully, Kremer, Meade, Graham, Dudgeon, 1998).

In sum, prior research indicates that physical exercise is beneficial for the general health of the individual, reducing the risk of depression as well as improving the overall quality of life.

1.3 The Present Research

The vast majority of studies on *happiness and SWB* have been cross-sectional, examining between-subject rather than within-subject effects (Lyubomirsky et al., 2005). In

consequence, there is more data about the difference in happiness between groups of individuals, than about the effect that one or more variables may have over time within the happiness of one group of individuals. The long-term investigation and possible long-term effects have been neglected in the past (Helgadóttir et al., 2017; Reed & Buck, 2009; Hassmén, Koivula, & Uutela, 2000).

Furthermore, most of the studies about *exercise* have been performed studying its association with a variety of physical and psychological disorders. Consequently, some authors consider the importance to further study the preventive approach of the relation of exercise and SWB, not only focusing on decreasing negative emotions or affects, but measuring positive effects and consequences (Stubbe, de Moor, Boomsma, de Geus, 2007). This can additionally provide the possibility to further investigate the preventive approach of the correlation, which still seems to be under-explored (Edwards et al., 2018).

The aim of the present research was to test, whether exercising increases the SWB over time. Therefore, the relation between exercise and SWB was investigated on a long-term basis, over 30 weeks, conducting evaluations in pre-defined intervals on individuals performing regular physical exercise in a gym. In addition, the analysis is based on regular exercise sessions instead of acute, one time only events. The evaluations take place, by using the World Health Organization-5 (WHO-5) index. The WHO-5 index is based on questions, focusing on positive measures and their development. This steers the study away from focusing on the reduction of negative aspects and provides a bigger sense of generalization, as it is needed.

1.4 Hypotheses

Considering the connection between SWB and exercise in the literature discussed above, the following hypotheses were formulated:

- **Hypothesis 1.** It is expected that SWB will increase four weeks after starting the gym membership.
- **Hypothesis 2.** The increase of SWB from baseline to week 4, will be positively associated with the frequency of gym attendance.

Different studies (e.g., Craft & Landers, 1998, as cited in Reed & Ones, 2006; North, McCullag & Tran, 1990, as cited in Reed & Ones, 2006) support the idea that individuals with

less positive or more negative affect before the bout of exercise, will show greater after-exercise improvements on their SWB compared to those in the opposite situation. The same effect can be expected with regular exercise: results show larger effects for lower baseline positive affect (Reed & Buck, 2009), therefore:

- **Hypothesis 3.** It is further expected that baseline SWB will moderate the relationship between gym attendance and SWB at week 4, with participants low in baseline SWB showing a stronger relationship.

Based on the already explained phenomena of adaptation, the following hypotheses were formulated:

- **Hypothesis 4.** SWB will decrease 15 weeks after starting the gym membership, as compared with SWB at week 4, and reach the baseline level.

Within the multiple benefits that exercising gives to the individual, increasing positive activated affect is one of them and can last up to 30 minutes after the bout is finished (Reed & Ones, 2006). This increase is best obtained with regular exercise and it is lost if the routine is discontinued (Kritz-Silverstein et al., 2001, cited by Reed & Buck, 2009). Thus, it is expected that:

- **Hypothesis 5.** The decline in SWB in week 15 will be moderated by the decline of gym attendance, the more participants reduce their gym attendance from week 4 to week 15, the more their SWB will decline.

It has been suggested in several studies that affective changes related to exercise are an important part of the exercise adherence (Wankel, 1993, as cited in Reed & Ones, 2006). Therefore, stronger adherence in those whose SWB got higher improvements can be expected. The more often people exercise, the more aware they become of the mood elevation associated; thus, they are more motivated to continue exercising (Hsiao & Thayer, 1997) The following hypothesis was formulated:

- **Hypothesis 6.** The increase in subjective well-being from baseline to week 15, will positively predict gym attendance at week 30.

2. Methods

2.1 Participants and Design

The present longitudinal multicenter study was carried out within 16 different gyms and fitness centers throughout Germany. It is based on a sample size of 324 participants (196 female; 128 male). Their age ranges from 18 – 60 years (*M* = 33.65; *SD* = 13.08). Of all participants, 183 (56.5%) had stated prior gym experience and 219 (67.6%) had stated prior sport and exercise experience.

The participants were individuals who had just signed up as a member of the gym or fitness center. The participation was voluntary and no reimbursement for the participation was given, except for a "one week free trial", as common with such memberships. Therefore, a motivation of participation due to an incentive can be excluded. The study has a prospective and longitudinal design and uses the WHO-5 questionnaire, which had to be filled in online on four distinct measurement times: baseline (T1), week 4 (T2), week 15 (T3), and week 30 (T4). A total of 324 participants completed the baseline survey in T1. At follow-ups, the dropout rates due to late responses or unwillingness to go through retesting were 0 (T2), 64 (T3), and 64 (T4).

The study took place from August 2016 to September 2017. Baseline and follow-up measurements were running all year to avoid seasonal effects.

2.2 Measures

Two main variables, well-being and gym attendance, were measured.

The measurement of *well-being* was done via the use of the World Health Organization 5-item Well-Being Index (WHO-5), a short questionnaire which measures the current state of well-being of an individual (Topp, Østergaard, Søndergaard, & Bech, 2015). The WHO-5 consists of five items which are rated by the respondents in relation to their frequency (0 = *"at no time"* to 5 = *"all the time"*) over the past two weeks (an example item is: "I have felt calm and relaxed"). The complete questionnaire can be found in *Appendix 1*.

The gym attendance was measured as the self-reported training time in days per week. Participants reported the mean number of days per week in which they visited the

gym in the particular measurement period, with the possible score ranging from 0 (*when a participant did not even attended the gym once during the week*) to 7 (*when a participant attended the gym every single day of the week*).

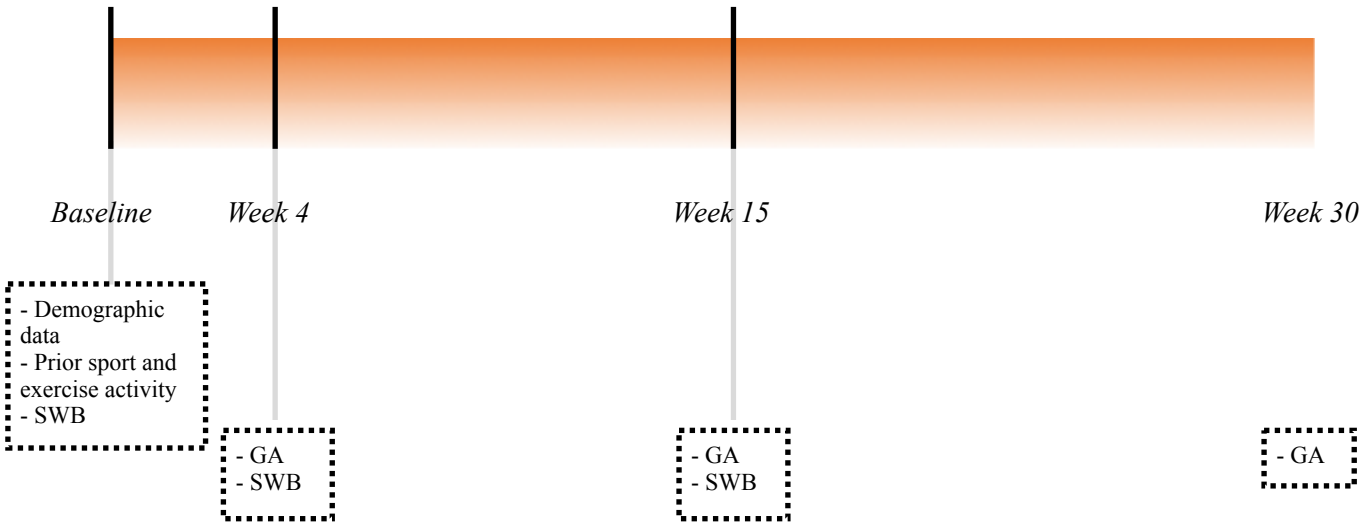
2.3 Procedure

Already existing contacts to different gyms and fitness studios were used to approach individuals who just signed up as a new member to the respective gym or studio and inform them about the study. The individuals who expressed interest and were willing to participate, received further detailed information from the trainer. Additionally, they signed a document of consent.

Online questionnaires were send at four different occasions during the time of the study: Within the first week after starting the gym membership (T1) a link to an online questionnaire was send to all participants by E-Mail, measuring demographic variables as well as the current state of subjective well-being. The psychological variables were collected via the answers to the WHO-5. Over time, three more questionnaires were sent out four (T2), 15 (T3) and 30 weeks (T4) after starting the gym. Information about subjective well-being was collected at T1, T2 and T3, while the self-reported gym attendance was assessed at T2, T3 and T4 (*See Figure 1*). For each online questionnaire, the participants received a link, which allowed them to log-in with their unique individual access code. The questionnaires were programmed in Inquisit 4.0 (Millisecond Software, Seattle, WA, USA).

Figure 1

Timeline of measurements for SWB and GA



Note. Times of Measurement correspond with *T1* = baseline; *T2* = week 4; *T3* = week 15; *T4* = week 30.

3. Results

For reliability analysis, Cronbach's alpha was calculated to assess the internal consistency of the WHO-5 questionnaire at Baseline (.84), Week 4 (.83) and Week 15 (.89). The alpha coefficient suggests that the items have adequate internal consistency.

I hypothesized that SWB will increase four weeks after starting the gym membership (Hypothesis 1) and later decrease at week 15, reaching its baseline level (Hypothesis 4). For this purpose, a one-way repeated measured analysis of variable (ANOVA) was conducted, to test whether there was an effect of Time (independent variable) on SWB (dependent variable) from baseline to week four and to week 15 (see *Table 1*).

There was a significant effect of Time, Wilks' Lambda = .93, $F(2, 258) = 10.52$, $p < .005$, $n^2 = .075$. Mauchly's Test of Sphericity indicated that the assumption of sphericity had been violated, $\chi^2(2) = 19.32$, $p < .001$. The value of ε for Huynh-Feldt = .94 (this number is lower in magnitude as the sphericity assumption is more greatly violated). As it is > .75, I consider the test of within-subjects effects with its correction, $M^2 = 3.96$, $F(1.88, 486.51) = 7.73$, $p = .001$.

In addition, three paired samples t-tests were used to make post hoc comparisons between conditions (see *Table 2)*. A first paired samples t-test indicated a significant difference in SWB between the baseline (*M* = 4.05, *SD* = .95, *N* = 324) and week 4 (*M* = 4.27, *SD* = .85, *N* = 324); *t*(323) = -4.12, *p* < .005. Likewise, a second paired samples t-test indicated a significant difference in SWB between Week 4 (*M* = 4.29, *SD* = .82, *N* = 260) and Week 15 (*M* = 4.08, *SD* = .99, *N* = 260), *t*(259) = 3.82, *p* < .005. Nevertheless, a third paired samples t-test indicated a non-significant statistical difference in SWB between its baseline value (*M* = 4.10, *SD* = .93, *N* = 260) and week 15 (*M* = 4.08, *SD* = .99, *N* = 260), *t*(259) = .221, *p* = .825.

Table 1

Means and Standard Deviations in SWB (ANOVA)

Measure	Baseline (T1)		Week 4 (T2)		Week 15 (T3)	
	M	*SD*	*M*	*SD*	*M*	*SD*
SWB	4.10	.93	4.29	.82	4.08	.99

Note. N = 260

Table 2

Paired Differences within SWB

	M	SD	95% CI		t	df	*p*
			LL	*UL*			
SWB T1 – SWB T2	-.21	.93	-.31	-.11	-4.12	323	<.001
SWB T2 – SWB T3	.20	.87	.10	.31	3.82	259	<.001
SWB T1 – SWB T3	.01	1.07	-.12	.14	.22	259	.825

Note. CI = Confidence Interval of the Difference; *LL* = lower limit; *UL* = upper limit.

I hypothesized that the increase of SWB between the baseline and week 4 will be positively associated with the frequency of gym attendance (Hypothesis 2). For this purpose, I conducted a regression analysis controlling for baseline level of SWB (see *Table 3*).

A hierarchical multiple regression was run to determine, if the addition of Gym Attendance (over the last 4 weeks -training days/week-) improved the prediction of SWB at Week 4 over and above Baseline SWB alone. See *Table 4* for full details on each regression model.

The results indicate that Baseline SWB can alone account for the value of SWB four weeks later with more statistical significance than when combined with Gym Attendance at Week 4. The full model of Baseline SWB and Gym Attendance at Week 4 to predict SWB at Week 4 (Model 2) was at the margin of statistical significance, $R^2 = .228$, $F(2, 317) = 46.92$, $p = .069$; adjusted $R^2 = .224$., and the addition of Gym Attendance at Week 4 to the prediction of SWB at Week 4 (Model 2) led to an increase in R^2 of .008, $F(2, 317) = 3.34$, $p = .069$.

Table 3

Means and Standard Deviations in SWB and Gym Attendance

Measure	Baseline (T1)			Week 4 (T2)			Week 15 (T3)			Week 30 (T4)		
	N	*M*	*SD*	***N***	*M*	*SD*	***N***	*M*	*SD*	***N***	*M*	*SD*
SWB	320	4.06	.95	320	4.27	.85	260	4.08	.99			
Gym Attendance				320	2.37	1.02	258	2.04	1.12	194	1.81	1.16

Note. For Gym Attendance at Week 30: valid $N = 189$.

I hypothesized that baseline SWB would moderate the relationship between Gym Attendance and SWB at week 4 (Hypothesis 3). For this purpose, I conducted a regression analysis using Process v3.5 by Andrew F. Hayes.

The results of the overall model: $F(3, 316) = 37.18$, $p < .001$, $R^2 = .26$

When using Gym Attendance at Week 4 as a predictor of SWB at Week 4, for every 1 unit increase in days/week, there is .75 increase in SWB at Week 4 ($p < .001$). Likewise, for every 1 unit increase of Baseline SWB, there is .83 increase in SWB at Week 4 ($p < .001$). However, the effect of the combine action of both predictors is less than the sum of the individual effects. In other words, the increase of one predictor, will decrease the significance effect of the other. See *Table 5* for full details.

Table 4

Multiple Regression Analysis of Gym Attendance on SWB at Week 4 (controlling for Baseline SWB)

	SWB Week 4 (T2)					
	Model 1			Model 2		
Variable	*B*	*β*	*p*	*B*	*β*	*p*
Constant	2.57		< .001	2.41		< .001
Baseline SWB	.42	.47	< .001	.41	.46	< .001
Gym Attendance Week 4				.08	.09	.069
R^2	.22			.23		
F	89.84			46.92		
ΔR^2	.22			.01		
ΔF	89.84			3.34		

Note. $N = 260$.

Table 5

Regression Analysis using Process v3.5

	SWB Week 4 (T2)		
Variable	*b*	*t*	*p*
Constant	.74	1.51	.13
Gym Attendance Week 4	.75	4.04	< .001
Baseline SWB	.83	6.92	< .001
Interaction	-.17	-3.73	< .001

Note. $N = 320$.

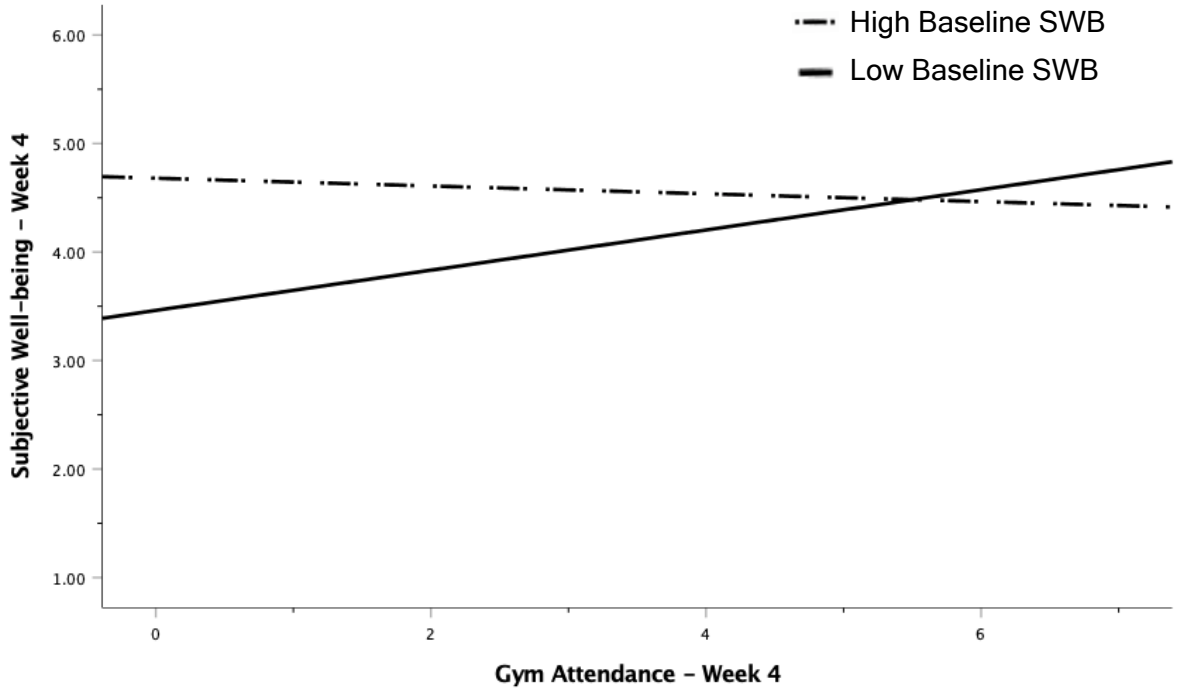
For low Baseline SWB (1SD below the mean), Gym Attendance at week 4: $b = .23$, $t(316) = 3.97$, $p < .001$. For mean Baseline SWB, Gym Attendance at week 4: $b = .07$, $t(316) = 1.74$, $p = .083$. For high Baseline SWB (1SD above the mean), Gym Attendance at week 4 $b = -.09$, $t(316) = -1.48$, $p = .139$.

When the Baseline SWB is 4.00 or less, Gym Attendance and SWB (week 4) have a significant positive relation, $t(316) = 1.97$, $p = .05$, $b = .08$. The relation between Gym Attendance and SWB (week 4) is not significant when the baseline SWB is between 4.02 and 5.12. When the baseline SWB is 5.30 or more, Gym Attendance and SWB (week 4) have a significant negative relation, $t(316) = -1.97$, $p = .05$, $b = -.14$.

As Baseline SWB decreases, the relationship between Gym Attendance and SWB (both at week 4) becomes more positive (see *Figure 2*).

Figure 2

Comparison between low and high Baseline SWB



Notes. GA is measured in days/week over the last 4 weeks. *SWB* is measured (1 to 6) with the WHO-5 questionnaire. *Low SWB in T1*, R^2 *Linear* = .053; *high SWB in T1*, R^2 *Linear* = .002.

Regarding the changes in SWB from Week 4 to Week 15, I hypothesized that its decline would be moderated by the decline of Gym Attendance, the more participants reduce their Gym Attendance from week 4 to week 15, the more their SWB will decline (Hypothesis 5). For this purpose, I conducted a regression analysis controlling for SWB at Week 4.

The participants' gym attendance decreased from Week 4 to Week 15 by an average of 0.38 days/week (*SD* = 1.02, *N* = 255). A hierarchical multiple regression was run to determine, if the addition of this decrease in Gym Attendance improved the prediction of SWB at Week 15 over and above SWB at Week 4 alone. See *Table 6* for full details on each regression model.

The results indicate that both variables, SWB at Week 4 and Gym Attendance's Decrease, can predict SWB at Week 15 with high statistical significance. Accordingly, the full model (Model 2), R^2 = .312, $F(2, 252) = 57.129$, $p < .001$; adjusted R^2 = .307; the addition of

Gym Attendance's Decrease led to a statistically significant increase in R^2 of .023, $F(2, 252) = 8.364$, $p = .004$.

In order to have a deeper understanding of the variations in SWB along the different times of measurement, I divided the participants into two groups. The Dropout Group, composed by those whose Gym Attendance decreased from Week 4 to Week 15, and Maintainer Group, with those participants whose Gym Attendance didn't decrease. See *Table 7* for full results. An independent sample t-test was run to make the comparison.

There was a statistically significant difference in mean SWB between Dropout and Maintainer groups at Week 15, $t(173.12) = -3.4$, $p = .001$. While at Baseline and Week 4, the difference between the two groups was not statistically significant: Baseline, $t(179.62) = -.91$, $p = .364$; Week 4, $t(166.95) = -1.11$, $p = .268$; it is necessary to consider that the decrease in Gym Attendance with which I made the group division, occurs between Week 4 and Week 15.

The more Gym Attendance declines from week 4 to week 15, the lower the SWB at week 15. Gym Attendance declined from week 4 to week 15 (measured in hours per week), $M = .38$, $SD = 1.02$, $N = 255$.

Table 6

Multiple Regression Analysis of Gym Attendance's decline (from week 4 to week 15) on SWB at Week 15 (controlling for SWB at Week 4)

	SWB Week 15 (T3)					
	Model 1			Model 2		
Variable	*B*	*β*	*p*	*B*	*β*	*p*
Constant	1.27		< .001	1.41		< .001
SWB Week 4	.66	.54	< .001	.64	.52	< .001
Gym Attendance's decline				-.15	-.15	.004
R^2	.29			.31		
F	102.90			57.13		
ΔR^2	.29			.02		
ΔF	102.90			8.36		

Note. $N = 255$.

I hypothesized that the increase in SWB from baseline (T1) to week 15 (T3) will positively predict Gym Attendance at week 30 (T4) (Hypothesis 6).

For this purpose, I conducted a regression analysis controlling for Gym Attendance at Week 15. SWB did not increase, but decreased from Baseline to Week 15; therefore, the SWB's "increase" is a negative number; $M = -.03$, $SD = 1.01$, $N = 192$.

A hierarchical multiple regression was run to determine, if the addition of this change in SWB improved the prediction of Gym Attendance at Week 30 over and above Gym Attendance at Week 15 alone. See *Table 8* for full details on each regression model. The full model was not statistically significant, $R^2 = .401$, $F(2, 189) = 63.236$, $p = .103$; adjusted $R^2 = .395$. The addition of SWB's change to the prediction of Gym Attendance at Week 30 (Model 2) led to an increase in R^2 of .009, $F(2, 189) = 2.688$, $p = .103$. SWB did not increase but

decrease from Baseline to Week 15, therefore the SWB's "increase" is a negative number; *M* = -.03, *SD* = 1.01, *N* = 192.

Table 7

Values of SWB for dropout and maintainer groups.

	Baseline (T1)		Week 4 (T2)		Week 15 (T3)	
	M	*SD*	*M*	*SD*	*M*	*SD*
Dropout	4.02	1.04	4.24	.85	3.81	1.04
Maintainer	4.16	.88	4.33	.79	4.26	.92

Note. Dropout, *N* = 93; *Maintainer*, *N* = 162.

Table 8

Multiple Regression Analysis of SWB's increase (from Baseline to week 15) on Gym Attendance at Week 30 (controlling for Gym Attendance at Week 15)

	Gym Attendance Week 30 (T4)					
	Model 1			Model 2		
Variable	*B*	*β*	*p*	*B*	*β*	*p*
Constant	.46		.001	.43		.002
Gym Attendance Week 15	.66	.63	< .001	.68	.64	< .001
SWB's increase				-.11	-.93	-.103
R^2	.39			.40		
F	122.69			63.24		
ΔR^2	.39			.01		
ΔF	122.69			2.69		

Note. N = 192.

4. Discussion

In this research, I examined the long-term relationship between SWB and exercise. Analyzing the SWB at three different times: baseline, week 4, and week 15; participants' SWB increased from baseline to week 4, and later decreased at week 15 reaching the baseline level. These findings support Hypotheses 1 and 4; and are in line with the previously discussed concept of hedonic adaptation, and the tendency of humans to adapt to changes finding their levels of happiness usually around a baseline.

Nevertheless, as described earlier, exercise is not a life circumstance but an intentional activity. It can be argued that once an intentional activity becomes more habitual, and thus, less effort is required, it can be considered as a life circumstance, or at least the distinction between the two categories becomes less clear. However, this outcome is very unlikely in only 15 weeks. This suggests that the SWB did not return to the baseline due to the adaptation.

Indeed, the decline in SWB was moderated by the decline of gym attendance. The more the participants reduced their gym attendance from week 4 to week 15, the more their SWB declined. This supports Hypothesis 5, and emphasizes the benefits of physical exercise as well as the disadvantages of discontinuing its practice. These findings are consistent with those reported by previous research (e.g. Helgadóttir et al., 2017; DiLorenzo et al., 1999).

Furthermore, the increase of SWB between baseline and week 4, was associated with the frequency of gym attendance during that same period of time. However, the significance of these results was at the margin of statistical significance. This partially supports Hypothesis 2 and speaks again for the benefits of exercising, when an increase of SWB is intended.

An explanation for these results is that exercise helps to raise the SWB till a certain level, after which, the periodicity of exercise becomes necessary to maintain SWB at the same level. Thus, the benefit for the individual switches from a gain to a no-loss situation. In other words, while in the beginning the effort of exercising is rewarded with an increase in the SWB, later in time, a further increase is no longer possible and the effort is compensated

with a maintenance of SWB. This might be a factor affecting the motivation of the participants and a cause for the decrease in gym attendance from week 4 to week 15, and from week 15 to week 30. Additionally, the *dropout group* (those participants whose gym attendance decreased from week 4 to week 15) had a significant decrease in SWB from week 4 to week 15; while the *maintainer group* kept the SWB relatively stable. It is interesting, that both the *dropout* and the *maintainer group* had a similar significant improvement in SWB from baseline to week 4. This suggests that the behavior of reducing or maintaining gym attendance is not related to the initial benefits experienced in SWB. To better understand the reasons for the decrease in gym attendance, further investigation into the motivation for this behavior could be subject for further studies. It is still unanswered why the participants reduced their gym attendance if their SWB raised. Nevertheless, SWB is not sufficient to explain the motivations or the goals of an individual, and the dropout could have been product of a hidden price for happiness that not everybody was willing to pay. Behaviors and cognitive activities require a degree of engagement from the individual; and when the effort required overwhelms the intentions or capabilities of the individual, they cease to occur.

Those participants with low baseline SWB had more improvements from exercising than those with high baseline SWB. In other words, baseline SWB was a moderator of the relationship between gym attendance and SWB at week 4; with participants low in baseline SWB showing a stronger relationship and a higher increase of SWB. This is in line with the results from the meta-analysis done by Reed & Buck (2009). Therefore, Hypothesis 3 is supported.

The change in SWB from baseline to week 15 could not predict gym attendance at week 4, thus, Hypothesis 6 is not supported. For further studies, it may be interesting to investigate for predictors of gym attendance.

Limitations

A few limitations which might have an influence on the results and possibilities for interpretation of this study have been identified.

All results are based on the participants of the study, which actively measured SWB as well as their gym attendance. There was no control group of non-exercisers, with whom

the results and especially the movement in SWB could be compared to. Additionally, the prior sport or exercise experience of the participants was not considered as a possible moderator on the changes in SWB and gym attendance during the time of the study.

While the gym attendance measured for this study might imply some inaccuracies, as it was self-reported; what has not been measured were the duration and intensity of the exercise time. The right combination of duration and intensity might have a negative or positive effect on the results of the measured SWB, but have not been considered for this study.

Furthermore, scientific studies rely on the assumption that happiness is a subjective feeling, and in order to collect data about happiness, asking participants about how they are feeling is all what is needed to evaluate their state of happiness. Although cognitive and physiological indicators provide promising alternatives that could potentially address problems related with self-reported methods, it is unlikely that they will be able to replace them in the near future (Diener, Lucas, & Oshi, 2018). The self-reported measurement of SWB has another limitation, which is the possible influence of outside factors when answering the questionnaire. It is possible that other events, not in connection with the study, influence the answers given, if these events overlap with the reporting.

In present times, humans sanctify the *subjective feeling* of individuals. Feelings are the supreme source of authority; entitled to many sorts of responsibilities, from voting for the next president, to defining art, and to controlling the market. Voters know best, beauty is in the eye of the beholder, and the customer is always right (Harari, 2015).
The idea of uniqueness of each individual, is giving to the *feelings* a fundamental importance, and thus, a fundamental responsibility.

Buddhism has a different approach. It shares the basic insight of the biological approach: happiness results from processes occurring within ones body and not from events of the outside world. As suffering arises from identifying oneself with ones emotions, and making life a constant chase of ephemeral sensations. In other words, for Buddhism, inner contentment comes from appreciating what one has, rather than having what one wants (The Dalai Lama & Cutler, 1999).

By the year 2021, there is no scientific explanation of how a collection of billions of electric brain signals can create subjective experiences. Human cells are composed by around 100 trillion atoms, is there any movement of even a single one of them that is caused by the subjective experience of the individual rather than by the prior movement of some other particle?

Conclusion

Exercise has proven to raise the SWB of the individuals, with higher improvements in those with low initial SWB. Furthermore, exercise plays an important role in the maintenance of SWB, and if it is discontinued, SWB decreases accordingly.

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Appendix 1

Psychiatric Research Unit
WHO Collaborating Centre in Mental Health

WHO (Fünf) - FRAGEBOGEN ZUM WOHLBEFINDEN ´
(Version 1998)

Die folgenden Aussagen betreffen Ihr Wohlbefinden in den letzten zwei Wochen. Bitte markieren Sie bei jeder Aussage die Rubrik, die Ihrer Meinung nach am besten beschreibt, wie Sie sich in den letzten zwei Wochen gefühlt haben.

In den letzten zwei Wochen …	**Die ganze Zeit**	**Meistens**	**Etwas mehr als die Hälfte der Zeit**	**Etwas weniger als die Hälfte der Zeit**	**Ab und zu**	**Zu keinem Zeitpunkt**
… war ich froh und guter Laune	5	4	3	2	1	0
… habe ich mich ruhig und entspannt gefühlt	5	4	3	2	1	0
… habe ich mich energisch und aktiv gefühlt	5	4	3	2	1	0
… habe ich mich beim Aufwachen frisch und ausgeruht gefühlt	5	4	3	2	1	0
… war mein Alltag voller Dinge, die mich interessieren	5	4	3	2	1	0

Punktberechnung
Der Rohwert kommt durch einfaches Addieren der Antworten zustande. Der Rohwert erstreckt sich von 0 bis 25, wobei 0 das geringste Wohlbefinden/niedrigste Lebensqualität und 25 grösstes Wohlbefinden, höchste Lebensqualität bezeichnen.

Den Prozentwert von 0 -100 erhält man durch Multiplikation mit 4. Der Prozentwert 0 bezeichnet das schlechteste Befinden, 100 das beste.