

Predicting Life Satisfaction Using Artificial Neural Networks Based on Gratitude, Meaning in Life, Self-Compassion, and Resilience

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ABSTRACT

Objective: This study aimed to develop and evaluate an artificial neural network model for predicting life satisfaction among adults in Germany based on gratitude, meaning in life, self-compassion, and resilience.

Methods and Materials: This cross-sectional predictive study was conducted on 1,162 adults in Germany. Data were collected using standardized self-report instruments, including the Satisfaction with Life Scale, Gratitude Questionnaire–Six Item Form, Meaning in Life Questionnaire, Self-Compassion Scale–Short Form, and Connor–Davidson Resilience Scale. After data screening, descriptive statistics, reliability analysis, Pearson correlations, and artificial neural network modeling were performed. The dataset was divided into training, validation, and testing subsets. A multilayer feedforward neural network was developed using standardized predictor variables, with model optimization performed through the Adam algorithm, early stopping, and dropout regularization. Model performance was evaluated using MAE, MSE, RMSE, R², explained variance, permutation feature importance, and SHAP analysis.

Findings: Pearson correlation analysis showed that all predictor variables had significant positive associations with life satisfaction. Resilience had the strongest correlation with life satisfaction, followed by self-compassion, meaning in life, and gratitude. The artificial neural network demonstrated strong predictive accuracy, explaining 86.5% of the variance in life satisfaction in the training set, 84.9% in the validation set, and 84.2% in the testing set. Prediction errors remained low across all datasets, indicating stable model performance and limited overfitting. Feature-importance analyses showed that resilience was the most influential predictor of life satisfaction, followed by self-compassion, meaning in life, and gratitude.

Conclusion: The findings indicate that life satisfaction can be predicted with high accuracy using an artificial neural network model based on positive psychological resources. Resilience, self-compassion, meaning in life, and gratitude jointly provide a strong predictive framework for understanding subjective well-being.

Keywords: Life satisfaction; artificial neural network; gratitude; meaning in life; self-compassion; resilience; positive psychology.

1. Introduction

Life satisfaction is one of the central indicators of subjective well-being and reflects the cognitive evaluation individuals make regarding the quality, coherence, and desirability of their lives. Unlike transient affective states, life satisfaction represents a broader judgment through which individuals compare their actual life conditions with their internal standards, aspirations, values, and expectations. In contemporary positive psychology, life satisfaction is increasingly understood not merely as the absence of psychological distress, but as a multidimensional outcome shaped by personal strengths, existential resources, adaptive emotional regulation, relational connectedness, and the capacity to interpret life experiences in constructive ways. This shift has encouraged researchers to move beyond deficit-oriented models of mental health and to examine the psychological resources that help individuals sustain well-being under ordinary and adverse circumstances. In this regard, gratitude, meaning in life, self-compassion, and resilience have emerged as particularly important constructs because they represent complementary pathways through which individuals interpret experiences, regulate emotional responses, maintain purpose, and adapt to challenges. Recent work in positive psychology and lifestyle-oriented mental health has emphasized that well-being is embedded in patterns of connectedness, meaning, adaptive cognition, and intentional health-promoting practices, highlighting the importance of integrated psychological models for explaining life satisfaction (Merlo et al., 2025; Robbins, 2021).

The growing scientific interest in positive psychological resources has been strengthened by evidence showing that interventions based on gratitude, mindfulness, self-compassion, spirituality, and resilience can improve well-being across diverse populations and settings. Positive psychology interventions have been conceptualized as structured strategies designed to cultivate adaptive emotions, strengths, values, and behavioral practices that enhance subjective well-being and psychological functioning. Systematic and review-based evidence has shown that such interventions may offer meaningful opportunities to promote well-being, particularly when they are adapted to cultural, clinical, educational, and occupational contexts (Basurrah, Baddar, et al., 2022; Basurrah, Blasi, et al., 2022). Mindfulness-based positive psychology interventions have also been shown to integrate attentional awareness, emotional regulation, and acceptance-oriented processes,

thereby strengthening well-being through both cognitive and affective mechanisms (George et al., 2021). Similarly, digital positive psychology interventions have expanded the reach of these approaches among children, adolescents, and young adults, indicating that positive psychological constructs can be systematically targeted through scalable and technology-supported methods (Saboor et al., 2024). These developments suggest that the study of life satisfaction should consider multiple personal strengths simultaneously rather than treating well-being as the product of a single psychological factor.

Among the core predictors of life satisfaction, gratitude has received substantial attention because it involves the tendency to notice, appreciate, and respond positively to benefits, relationships, opportunities, and meaningful experiences. Gratitude is not limited to a polite emotional response; rather, it reflects an orientation toward life in which individuals become more aware of positive aspects of their environment and interpersonal world. As a mind-body-spirit practice, gratitude has been described as a resource that can optimize health and human functioning by reinforcing positive attention, relational appreciation, emotional balance, and psychological integration (Bryan & Hamilton, 2024). Gratitude practices have been examined in several applied contexts, including healthcare and occupational settings, where they have been associated with improvements in well-being, work engagement, and adaptive functioning (Desai et al., 2024). Gratitude-based approaches have also been studied in clinical populations; for example, gratitude journaling has been evaluated among patients with breast cancer, indicating the growing interest in gratitude as a potentially supportive practice in health-related adjustment (You & Kim, 2025). These findings suggest that gratitude may contribute to life satisfaction by helping individuals identify sources of value and appreciation even in circumstances marked by stress, uncertainty, or limitation.

Gratitude may be especially relevant to life satisfaction because it changes the interpretive frame through which individuals evaluate their experiences. Rather than focusing exclusively on deprivation, threat, or unmet expectations, grateful individuals are more likely to recognize support, opportunity, personal growth, and interpersonal kindness. This interpretive tendency may increase satisfaction by strengthening positive affect, reducing maladaptive comparison, and promoting a more balanced assessment of life circumstances. Research during the COVID-19 pandemic suggested that gratitude may contribute to

resilience and positivity during periods of collective stress, supporting the idea that gratitude is not only a pleasant emotion but also a psychological resource that may buffer adversity (Kumar et al., 2022). In high-risk and emotionally demanding contexts, gratitude has also been discussed in relation to suicide prevention and existential distress, indicating its relevance to psychological protection and meaning-oriented coping (Maumus, 2022). Furthermore, gratitude interventions have been examined as strategies for improving well-being and resilience among graduate nurses transitioning to professional practice, demonstrating the practical relevance of gratitude in stressful developmental and occupational transitions (Calleja et al., 2024). Therefore, gratitude can be considered a theoretically meaningful predictor of life satisfaction because it links positive attention, relational awareness, coping, and evaluative well-being.

Meaning in life is another major determinant of life satisfaction and refers to the extent to which individuals perceive their lives as coherent, purposeful, significant, and directed by personally important goals. Meaning provides an interpretive structure that allows individuals to organize experiences, tolerate difficulty, and connect daily activities with broader values. From an existential-humanistic perspective, well-being is deeply related to the ability to live with purpose, authenticity, and value-based engagement, particularly during periods of uncertainty and disruption (Robbins, 2021). Meaning has also been identified as an early determinant of mental health in children, highlighting that the search for and presence of meaning are not merely adult concerns but foundational aspects of psychological development (John et al., 2024). In broader well-being frameworks, meaning is often treated as one of the key domains through which individuals experience flourishing, alongside physical, emotional, social, intellectual, and occupational dimensions (Maragha et al., 2023). These theoretical and empirical perspectives suggest that meaning in life is likely to contribute substantially to life satisfaction because it helps individuals interpret their lives as purposeful and valuable.

Meaning in life may influence life satisfaction through several mechanisms. First, individuals who perceive their lives as meaningful are more likely to experience coherence between their values and behavior, which can increase satisfaction with personal choices and life direction. Second, meaning may reduce the negative impact of stress by allowing individuals to interpret difficulties as manageable, instructive, or connected to broader goals. Third, meaning

may support motivation and persistence, helping individuals maintain engagement with relationships, work, education, and personal development. This is consistent with broader positive psychology and spirituality literature, which has emphasized the importance of transcendence, purpose, and values in promoting psychological growth and well-being (Baysal, 2022). In occupational and caregiving contexts, the need to support mental wellness has become increasingly salient, particularly among professionals exposed to sustained emotional demands, and meaning may function as a protective resource in such settings (Pagani et al., 2025). Therefore, the inclusion of meaning in life as a predictor of life satisfaction is theoretically justified because it captures existential and motivational dimensions that are not fully explained by gratitude or resilience alone.

Self-compassion is also a critical psychological resource for understanding life satisfaction. It refers to the capacity to respond to personal suffering, failure, inadequacy, or distress with kindness, mindfulness, and a sense of shared humanity rather than harsh self-criticism, isolation, or over-identification with negative experiences. Self-compassion may enhance life satisfaction by reducing punitive self-evaluation and enabling individuals to maintain emotional balance when facing setbacks. In emerging adults, online self-compassion programs have shown feasibility and acceptability, reflecting the increasing recognition that self-compassion can be deliberately cultivated and delivered through accessible formats (Bluth et al., 2023). Self-compassion has also been examined in relation to work-family conflict, happiness, and life satisfaction among nurses, where it may moderate or mediate the relationship between occupational strain and well-being (Mogeda El Sayed El & Sarour, 2024). This is particularly relevant because life satisfaction is often affected by competing role demands, interpersonal responsibilities, and perceived failures to meet personal or social expectations. By promoting acceptance and emotional flexibility, self-compassion may help individuals evaluate their lives more positively even when their circumstances are imperfect.

The role of self-compassion in life satisfaction can also be understood through its interaction with gratitude and adversity. Evidence from research on child neglect and life satisfaction has shown that self-compassion and gratitude are important psychological factors in the well-being of vulnerable children, suggesting that these constructs may help reduce the long-term psychological burden of adverse experiences (Zhang & Li, 2021). Self-compassion may support life satisfaction by transforming the way individuals

relate to painful memories, personal limitations, and present difficulties. Instead of interpreting hardship as evidence of personal deficiency, self-compassionate individuals may be more capable of recognizing suffering as part of the common human condition. This orientation can reduce shame, strengthen emotional regulation, and allow individuals to pursue valued goals without excessive self-punishment. Adaptive repetitive thought has similarly been discussed as a transdiagnostic target for individuals prone to repetitive thinking styles, suggesting that the quality and adaptiveness of internal cognitive processes are important for mental health and well-being (Lawrence et al., 2021). In this sense, self-compassion may be viewed as a self-regulatory resource that reshapes internal dialogue and supports more stable evaluations of life satisfaction.

Resilience represents another essential component of well-being and refers to the capacity to adapt positively, recover from adversity, and sustain psychological functioning in the face of stress. Resilience is especially important in contemporary societies because individuals are exposed to increasing demands related to work instability, health challenges, social change, economic uncertainty, and relational strain. Research on adults has identified multiple factors influencing emotional resilience, including psychological, social, and contextual resources that shape how individuals respond to stress and adversity (Pahwa & Khan, 2022). Nursing and healthcare literature has also emphasized resilience-building models that integrate caring science, psychology, and neuroscience, suggesting that resilience is both a personal capacity and a process that can be strengthened through supportive environments and evidence-informed practices (Wei et al., 2021). Resilience-building practices have been discussed for women physicians, whose professional experiences often involve high responsibility, emotional burden, and systemic stressors, further demonstrating the relevance of resilience to well-being in demanding contexts (Hobgood & Jarman, 2024). Because life satisfaction depends not only on favorable circumstances but also on the ability to manage unfavorable ones, resilience is likely to be a strong predictor of satisfaction with life.

Resilience may contribute to life satisfaction by sustaining hope, adaptive coping, emotional regulation, and goal-directed behavior during difficult periods. In care home nursing, reviewed interventions designed to support resilience indicate that structured resources may help professionals maintain psychological functioning in settings characterized by chronic stress and emotional labor (Mallon

et al., 2023). Among neonatal intensive care unit staff, mHealth-based gratitude and mindfulness applications have been examined as tools for improving resiliency, illustrating the growing convergence between positive psychology, digital mental health, and occupational well-being (Peterson et al., 2024). Cognitive strategies and Stoic practices have similarly been discussed in nursing professional development, suggesting that resilience can be strengthened by cognitive reframing, emotional discipline, and values-based interpretation of challenges (Schimmels et al., 2024). These perspectives support the inclusion of resilience in predictive models of life satisfaction because resilient individuals are more likely to sustain positive evaluations of life despite stressors, losses, and uncertainty. Moreover, resilience may interact with gratitude, meaning, and self-compassion, creating a network of mutually reinforcing resources that shape subjective well-being.

The interconnected nature of gratitude, meaning in life, self-compassion, and resilience indicates that life satisfaction is unlikely to be explained adequately by simple linear or isolated associations. These constructs may influence life satisfaction both independently and interactively. For example, gratitude may enhance awareness of positive experiences, meaning may provide existential coherence, self-compassion may reduce self-directed distress, and resilience may support adaptation to adversity. The combined influence of these factors may produce nonlinear patterns in which the effect of one resource depends on the level of another. An individual with high gratitude but low resilience may experience well-being differently from an individual with high gratitude and high resilience. Similarly, meaning in life may have stronger effects on satisfaction when accompanied by self-compassion, because purpose without self-kindness may be experienced as pressure rather than fulfillment. The psychometric literature on positivity-related constructs has emphasized the importance of measuring adaptive orientations toward positive experience, further supporting the need to examine how positive psychological resources jointly contribute to well-being (Machlah & Zięba, 2021). Mindfulness programs for adolescents have also shown that subjective well-being can be improved by strengthening awareness and moment-to-moment engagement, indicating that well-being is produced through dynamic cognitive-affective processes rather than static traits alone (Primasari & Yuniarti, 2021).

Because of these complex relationships, artificial neural networks provide a promising analytical approach for

predicting life satisfaction. Traditional regression-based methods are useful for estimating linear associations and testing predefined hypotheses, but they may be limited when psychological variables operate through nonlinear, interactive, or threshold-based patterns. Artificial neural networks, in contrast, are data-driven predictive models capable of learning complex relationships between input variables and outcomes without requiring the researcher to specify all functional forms in advance. In the context of life satisfaction, neural networks may be particularly useful because subjective well-being is shaped by simultaneous interactions among emotional, cognitive, existential, and adaptive resources. The increasing use of digital interventions and scalable psychological technologies further supports the relevance of computational modeling in positive psychology and mental health research (Peterson et al., 2024; Saboor et al., 2024). In addition, broader applications of mindfulness and positive psychology in diverse fields, including conservation, healthcare, and professional development, indicate that psychological strengths are being studied in increasingly complex ecological and applied contexts (Gerber et al., 2023). Therefore, artificial neural networks may provide a more flexible and accurate method for identifying the relative and combined contributions of gratitude, meaning in life, self-compassion, and resilience to life satisfaction.

Despite the growing literature on positive psychological predictors of well-being, several gaps remain. First, many studies have examined gratitude, meaning, self-compassion, or resilience separately, whereas fewer studies have integrated these constructs into a single predictive framework. Second, much of the existing literature relies on intervention outcomes or correlational associations, while fewer studies employ machine learning methods to estimate predictive accuracy and feature importance. Third, although positive psychology interventions have been applied across healthcare, educational, professional, and digital contexts, there remains a need to clarify which psychological resources contribute most strongly to life satisfaction when considered simultaneously. Fourth, the adult population in Germany represents an important context for examining these relationships because individuals experience diverse social, occupational, and cultural conditions that may shape subjective evaluations of life. By using an artificial neural network model, the present study responds to these gaps by moving beyond isolated associations and examining the predictive structure of life satisfaction through an integrated, nonlinear modeling approach. This approach is consistent

with contemporary views of well-being as a multidimensional and dynamic construct shaped by personal strengths, adaptive cognition, relational awareness, existential meaning, and resilience-related processes.

The aim of this study was to develop and evaluate an artificial neural network model for predicting life satisfaction among adults in Germany based on gratitude, meaning in life, self-compassion, and resilience.

2. Methods and Materials

2.1. Study Design and Participants

This study employed a cross-sectional predictive research design to develop and evaluate an Artificial Neural Network (ANN) model for predicting life satisfaction using gratitude, meaning in life, self-compassion, and resilience as predictor variables. The study was conducted between March and July 2025 in Germany and recruited participants from several universities, workplaces, and community organizations located in Berlin, Munich, Hamburg, Frankfurt, and Cologne. A stratified convenience sampling strategy was adopted to ensure adequate representation across gender, age groups, educational backgrounds, and employment status. Individuals were eligible to participate if they were at least 18 years of age, had sufficient proficiency in the German language to complete the questionnaires independently, and provided informed consent before participation. Individuals with severe cognitive impairment or incomplete questionnaire responses exceeding 10% of the total items were excluded from the final analysis. Initially, 1,218 individuals agreed to participate. Following data screening for missing values, response consistency, duplicate submissions, and multivariate outliers, 1,162 complete datasets were retained for statistical analysis and machine learning modeling. This sample size was considered sufficient for both conventional statistical procedures and the development of robust artificial neural network models while minimizing the risk of overfitting.

2.2. Measures

Data were collected using a structured online questionnaire consisting of demographic questions followed by standardized psychological assessment instruments with well-established psychometric properties. Demographic information included age, gender, marital status, educational attainment, employment status, monthly income category, and place of residence. Life satisfaction, which served as the

dependent variable, was measured using the Satisfaction with Life Scale (SWLS). The SWLS consists of five items rated on a seven-point Likert scale ranging from strongly disagree to strongly agree, with higher scores indicating greater global life satisfaction. Gratitude was assessed using the Gratitude Questionnaire–Six Item Form (GQ-6), which measures individuals' general disposition toward experiencing and expressing gratitude. Responses are recorded on a seven-point Likert scale, and higher scores indicate greater gratitude. Meaning in life was measured using the Meaning in Life Questionnaire (MLQ), which includes two complementary dimensions assessing the presence of meaning and the search for meaning through ten items scored on a seven-point Likert scale. Self-compassion was evaluated using the Self-Compassion Scale–Short Form (SCS-SF), which measures self-kindness, common humanity, and mindfulness while also assessing reduced self-judgment, isolation, and over-identification. Participants responded using a five-point Likert scale, with higher scores reflecting greater self-compassion. Psychological resilience was assessed using the Connor–Davidson Resilience Scale (CD-RISC-25), which consists of twenty-five items measuring adaptability, perseverance, emotional regulation, confidence, and recovery from adversity. Responses were recorded on a five-point Likert scale, with higher total scores indicating stronger resilience. Prior to the main analyses, the internal consistency of each instrument was evaluated using Cronbach's alpha and McDonald's omega coefficients. Construct validity was examined through confirmatory factor analysis, and descriptive statistics were calculated for all study variables. Missing data were minimal and handled using expectation-maximization procedures after confirming that the data were missing completely at random.

2.3. Data analysis

Data analysis was performed using IBM SPSS Statistics version 29, AMOS version 29, and Python version 3.12 with TensorFlow and Keras libraries for machine learning analyses. Descriptive statistics, including means, standard deviations, skewness, kurtosis, frequencies, and percentages, were computed to summarize participant characteristics and study variables. Pearson correlation coefficients were calculated to examine bivariate relationships among gratitude, meaning in life, self-compassion, resilience, and life satisfaction. Before developing the predictive model, all continuous variables

were standardized using z-score normalization to improve neural network training efficiency. The dataset was randomly divided into training (70%), validation (15%), and testing (15%) subsets while preserving the distribution of the outcome variable across all partitions. A multilayer feedforward artificial neural network with supervised learning was developed to predict life satisfaction. The input layer consisted of four predictor variables, while the output layer contained one continuous outcome variable representing life satisfaction scores. Different hidden-layer architectures were evaluated through hyperparameter optimization, and the final model included two hidden layers employing Rectified Linear Unit (ReLU) activation functions, whereas the output layer used a linear activation function appropriate for continuous prediction. Model training was performed using the Adam optimization algorithm with an adaptive learning rate and mean squared error as the loss function. Early stopping and dropout regularization were implemented to reduce overfitting and improve model generalizability. Model performance was evaluated using mean absolute error (MAE), mean squared error (MSE), root mean squared error (RMSE), coefficient of determination (R^2), and five-fold cross-validation. To enhance interpretability, permutation feature importance and SHapley Additive exPlanations (SHAP) analyses were conducted to quantify the relative contribution of gratitude, meaning in life, self-compassion, and resilience to the prediction of life satisfaction. Sensitivity analyses were also performed to examine the robustness and stability of the predictive model across different demographic subgroups, and statistical significance for conventional analyses was established at a two-tailed p-value of less than .05.

3. Findings and Results

A total of 1,162 participants were included in the final analysis. The mean age of the participants was 34.87 years ($SD = 11.42$), with ages ranging from 18 to 69 years. Of the total sample, 612 participants (52.7%) were female and 550 (47.3%) were male. Regarding marital status, 53.4% were single, 40.6% were married or living with a partner, and 6.0% were divorced or widowed. Most participants had completed at least a bachelor's degree (61.4%), while 22.8% held postgraduate qualifications, and the remaining participants had completed vocational or secondary education. Approximately 68.5% were employed full-time, 11.7% worked part-time, 12.3% were university students, and 7.5% were unemployed or retired. Participants

represented diverse occupational sectors including education, healthcare, engineering, business, public administration, and service industries. The demographic distribution indicated that the sample adequately represented

adults from different socioeconomic and educational backgrounds across Germany, providing an appropriate dataset for the development and validation of the predictive artificial neural network model.

Table 1

Descriptive Statistics, Reliability Coefficients, and Correlations Among Study Variables

Variable	Mean	SD	Cronbach's α	1	2	3	4	5
1. Gratitude	33.82	5.96	.90	—				
2. Meaning in Life	47.64	8.41	.91	.61**	—			
3. Self-Compassion	42.13	7.28	.92	.56**	.64**	—		
4. Resilience	73.86	11.35	.93	.58**	.67**	.71**	—	
5. Life Satisfaction	24.75	5.71	.89	.65**	.69**	.72**	.76**	—

Table 1 presents the descriptive statistics, reliability estimates, and Pearson correlation coefficients among the principal study variables. All psychological instruments demonstrated excellent internal consistency, with Cronbach's alpha coefficients ranging from .89 to .93, indicating high reliability for subsequent analyses. Participants reported relatively high levels of gratitude, meaning in life, self-compassion, resilience, and life satisfaction. Examination of the correlation matrix revealed that all predictor variables were significantly and positively associated with life satisfaction ($p < .01$). Among these relationships, resilience demonstrated the strongest

association with life satisfaction ($r = .76$), followed by self-compassion ($r = .72$), meaning in life ($r = .69$), and gratitude ($r = .65$). Furthermore, substantial positive intercorrelations were observed among the predictor variables themselves, ranging from .56 to .71, suggesting that these positive psychological constructs are closely interconnected while remaining sufficiently distinct to justify their simultaneous inclusion in the predictive model. The correlation coefficients did not indicate problematic multicollinearity, supporting the suitability of these variables for artificial neural network modeling.

Table 2

Artificial Neural Network Performance Across Training, Validation, and Testing Datasets

Performance Metric	Training Set	Validation Set	Testing Set
Mean Absolute Error (MAE)	1.74	1.88	1.95
Mean Squared Error (MSE)	5.31	5.92	6.14
Root Mean Squared Error (RMSE)	2.30	2.43	2.48
R^2	.865	.849	.842
Explained Variance (%)	86.5	84.9	84.2

The predictive performance of the artificial neural network is summarized in Table 2. The final ANN model demonstrated excellent predictive accuracy across all three datasets. During model training, the network achieved an R^2 value of .865, indicating that approximately 86.5% of the variance in life satisfaction was explained by gratitude, meaning in life, self-compassion, and resilience. Importantly, model performance remained highly stable during validation ($R^2 = .849$) and independent testing ($R^2 = .842$), suggesting excellent generalizability and minimal overfitting. The small differences between training,

validation, and testing errors further confirmed that the implemented regularization procedures and early stopping strategy effectively prevented excessive model complexity. The MAE values remained below two scale points across all datasets, while RMSE values were consistently below 2.50, indicating that prediction errors were relatively small compared with the observed range of life satisfaction scores. Overall, these findings demonstrate that the artificial neural network produced highly accurate and robust predictions of life satisfaction in previously unseen participants.

Table 3

Permutation Feature Importance and SHAP-Based Ranking of Predictor Variables

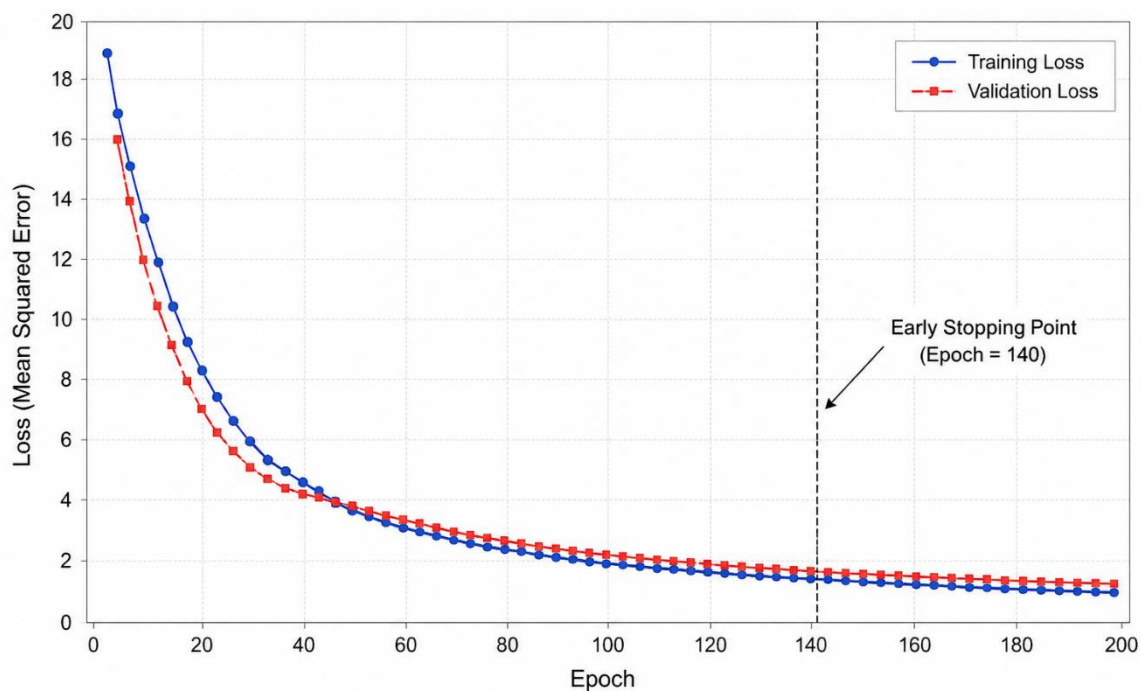
Predictor Variable	Permutation Importance	SHAP Mean Absolute Value	Relative Importance (%)	Rank
Resilience	0.321	0.442	33.4	1
Self-Compassion	0.274	0.381	28.7	2
Meaning in Life	0.221	0.319	22.4	3
Gratitude	0.166	0.244	15.5	4

Table 3 presents the contribution of each psychological variable to the prediction of life satisfaction using both permutation feature importance and SHAP analyses. Resilience emerged as the most influential predictor, accounting for approximately one-third of the model's total predictive importance, indicating that adaptive coping capacities and the ability to recover from adversity played the greatest role in determining individual differences in life satisfaction. Self-compassion represented the second most influential predictor, highlighting the importance of accepting personal imperfections and responding to life's challenges with kindness and emotional balance. Meaning in life ranked third, demonstrating that possessing a coherent sense of purpose substantially enhanced the prediction of subjective well-being beyond resilience and self-compassion. Gratitude also made a meaningful and

statistically important contribution to model performance, although its relative influence was somewhat smaller than the other predictors. Importantly, all four variables demonstrated substantial predictive value, confirming that life satisfaction is best understood as a multidimensional psychological construct influenced by several interrelated positive psychological resources. The SHAP values further revealed that higher levels of each predictor consistently contributed to increased predicted life satisfaction scores across participants, with no evidence of contradictory or unstable prediction patterns. Collectively, these findings indicate that the artificial neural network successfully captured both the individual and combined nonlinear contributions of gratitude, meaning in life, self-compassion, and resilience, providing a highly accurate model for predicting life satisfaction in the German adult population.

Figure 1

Training and Validation Loss Curves of the Artificial Neural Network During Model Optimization



The learning curves shown in Figure 1 illustrate the convergence behavior of the artificial neural network throughout the training process. Both the training and validation loss decreased rapidly during the early epochs before gradually stabilizing, indicating efficient learning of the underlying relationships among the predictor variables. The validation loss closely paralleled the training loss across successive iterations without exhibiting substantial divergence, suggesting that the model generalized effectively to unseen data. Early stopping terminated the optimization process once additional training no longer improved validation performance, thereby reducing the likelihood of overfitting. The smooth convergence pattern observed in the learning curves provides additional evidence that the selected network architecture, optimization algorithm, and hyperparameter configuration were appropriate for modeling the complex nonlinear relationships between gratitude, meaning in life, self-compassion, resilience, and life satisfaction. The figure therefore supports the overall stability and reliability of the final predictive model.

4. Discussion

The present study aimed to predict life satisfaction using an artificial neural network model based on gratitude, meaning in life, self-compassion, and resilience among adults in Germany. The findings showed that all four positive psychological variables were significantly and positively associated with life satisfaction, indicating that individuals with higher gratitude, stronger meaning in life, greater self-compassion, and higher resilience tended to report more favorable evaluations of their lives. The artificial neural network model demonstrated strong predictive performance, explaining 84.2% of the variance in life satisfaction in the independent testing dataset. This finding indicates that the selected predictors provided a highly informative psychological profile for estimating life satisfaction and that the nonlinear modeling approach was capable of capturing complex patterns among these variables. The training and validation loss curves further supported the stability of the model, as both curves decreased consistently and reached convergence without substantial divergence, suggesting that the model learned meaningful relationships rather than merely memorizing the training data. These findings support the growing argument that subjective well-being is best understood as a multidimensional construct shaped by emotional, cognitive,

existential, and adaptive psychological resources (Merlo et al., 2025; Robbins, 2021).

The correlation findings showed that resilience had the strongest bivariate association with life satisfaction, followed by self-compassion, meaning in life, and gratitude. This pattern was also confirmed by the feature-importance analyses, in which resilience emerged as the most influential predictor in both permutation importance and SHAP-based ranking. This result suggests that the capacity to recover from adversity, maintain psychological flexibility, regulate emotional responses, and continue goal-directed functioning under stress may be central to how adults evaluate their overall lives. Previous studies have similarly emphasized resilience as a major factor in adult emotional functioning and psychological adjustment. Pahwa and Khan highlighted that emotional resilience in adults is shaped by multiple personal and contextual resources, which may help individuals manage stress and preserve well-being during adverse experiences (Pahwa & Khan, 2022). Similarly, resilience-building models in nursing and health-related contexts emphasize that resilience is not merely a stable trait but an adaptive process supported by psychological awareness, self-regulation, relational support, and meaning-oriented coping (Wei et al., 2021). The present finding is therefore consistent with prior evidence suggesting that life satisfaction depends not only on positive life circumstances but also on the ability to adapt constructively when circumstances become difficult.

The strong predictive role of resilience is also consistent with recent applied studies in emotionally demanding professional environments. Research on women physicians has emphasized the importance of resilience-building practices for sustaining professional well-being, particularly when individuals are exposed to chronic pressure, responsibility, and systemic stressors (Hobgood & Jarman, 2024). Similarly, research on care home nurses has shown that resilience-supportive interventions are relevant for maintaining psychological functioning in high-burden care contexts (Mallon et al., 2023). These findings align with the present results by suggesting that resilience contributes to life satisfaction through adaptive coping, perseverance, and the capacity to maintain stability despite stress. The importance of resilience is also supported by studies of digital and mobile interventions designed to strengthen resiliency among healthcare workers, where gratitude and mindfulness-based practices were used to support psychological adaptation in stressful work environments (Peterson et al., 2024). In the current study, resilience may

have functioned as a broad psychological resource that integrated emotional regulation, stress tolerance, optimism, and behavioral persistence, thereby making it the strongest predictor of life satisfaction.

Self-compassion was identified as the second most important predictor of life satisfaction. This finding indicates that the way individuals relate to themselves during suffering, failure, or perceived inadequacy plays a substantial role in their overall evaluation of life. Individuals with higher self-compassion may be less likely to interpret difficulties as personal defects and more likely to respond to distress with kindness, balance, and acceptance. This interpretation is consistent with evidence showing that self-compassion-based programs can improve psychological outcomes and are feasible for populations such as emerging adults (Bluth et al., 2023). The present finding also aligns with research among nurses, where self-compassion was found to be involved in the relationship between work-family conflict, happiness, and life satisfaction (Mogeda El Sayed El & Sarour, 2024). In this sense, self-compassion may protect life satisfaction by reducing the damaging effects of self-criticism, emotional exhaustion, and role strain. It may also help individuals maintain a more realistic and accepting view of their lives, especially when they encounter setbacks or unmet expectations.

The importance of self-compassion in the model is further supported by studies linking self-compassion with well-being among vulnerable populations. Zhang and Li found that self-compassion and gratitude played important roles in the relationship between child neglect and life satisfaction, suggesting that these constructs can buffer the psychological consequences of adversity (Zhang & Li, 2021). This is highly relevant to the present findings because it suggests that self-compassion may enhance life satisfaction not only by increasing positive emotions but also by weakening the negative impact of past or present difficulties. In addition, adaptive repetitive thought has been described as a transdiagnostic mechanism that can help individuals manage repetitive thinking styles more constructively (Lawrence et al., 2021). Self-compassion may operate in a similar way by reshaping internal dialogue, reducing harsh self-judgment, and supporting more adaptive interpretations of personal difficulties. Therefore, the relatively high importance of self-compassion in the neural network model suggests that life satisfaction is strongly influenced by self-directed emotional regulation and the quality of individuals' relationship with themselves.

Meaning in life was the third strongest predictor of life satisfaction. This finding demonstrates that perceiving one's life as purposeful, coherent, and significant remains a critical component of subjective well-being. Meaning in life may strengthen life satisfaction by helping individuals connect daily experiences with broader values and long-term goals. The result is consistent with existential-humanistic approaches to positive psychology, which emphasize that well-being requires more than pleasure or comfort; it also involves purpose, authenticity, and the capacity to find significance in lived experience (Robbins, 2021). The finding also aligns with research showing that meaning is an early determinant of mental health in children, suggesting that the need for meaning is developmentally fundamental and remains important across the lifespan (John et al., 2024). Similarly, multidomain well-being frameworks recognize meaning as a central pathway through which individuals organize their psychological, relational, and functional lives (Maragha et al., 2023). Thus, in the present model, meaning in life likely contributed to life satisfaction by giving participants a sense of direction and coherence in evaluating their lives.

The role of meaning in life may also be interpreted in relation to spirituality, connectedness, and value-based living. Review-based work on positive psychology and spirituality has emphasized that well-being is enhanced when individuals experience purpose, transcendence, and alignment with deeper values (Baysal, 2022). Similarly, contemporary lifestyle psychiatry and lifestyle medicine increasingly identify connectedness as a central pillar of mental wellness, suggesting that well-being is strengthened when individuals feel connected to themselves, others, communities, and meaningful systems of value (Merlo et al., 2025). The present results are consistent with this perspective because life satisfaction was not predicted only by adaptive coping or emotional self-kindness, but also by existential appraisal. In professional and institutional contexts, mental wellness has also been framed as an important priority, especially in caregiving professions where meaning, recognition, and psychological sustainability are central to long-term functioning (Pagani et al., 2025). Therefore, meaning in life may represent the interpretive dimension of life satisfaction, allowing individuals to understand their lives as purposeful even when they face demands, stressors, or uncertainty.

Gratitude was also a significant and meaningful predictor of life satisfaction, although it had the lowest relative importance among the four predictors in the final model.

This does not indicate that gratitude is unimportant; rather, it suggests that when gratitude is examined simultaneously with resilience, self-compassion, and meaning in life, its unique contribution is somewhat smaller. Gratitude may enhance life satisfaction by helping individuals notice benefits, appreciate relationships, and reinterpret ordinary experiences in a more positive way. This interpretation is consistent with work describing gratitude as a mind-body-spirit practice that supports health and human functioning by cultivating appreciation, emotional balance, and positive orientation toward life (Bryan & Hamilton, 2024). Gratitude-based interventions have also been shown to improve well-being in healthcare and clinical settings, including randomized and interventional studies involving healthcare professionals and patients with breast cancer (Desai et al., 2024; You & Kim, 2025). Therefore, the present finding supports previous literature by showing that gratitude remains an important contributor to subjective well-being even when other positive psychological strengths are considered.

The contribution of gratitude is also aligned with studies showing that gratitude may support resilience and well-being during stressful transitions and crises. Kumar and colleagues found that gratitude was related to resilience, mental health, and positivity during the early phase of the COVID-19 pandemic, suggesting that gratitude can help individuals maintain psychological resources under conditions of uncertainty (Kumar et al., 2022). Gratitude has also been examined in relation to suicide prevention and psychological protection, suggesting that appreciative attention may contribute to hope and emotional stabilization in vulnerable contexts (Maumus, 2022). In professional transition contexts, gratitude interventions have been reviewed as strategies for improving well-being and resilience among graduate nurses entering practice (Calleja et al., 2024). The lower relative importance of gratitude in the present neural network model may therefore reflect its indirect or supportive role: gratitude may strengthen well-being partly through its connections with resilience, meaning, and self-compassion rather than only through a direct independent pathway. This interpretation is consistent with the positive intercorrelations observed among all predictors in the present study.

A major contribution of the present study is the use of an artificial neural network to predict life satisfaction. The high testing R^2 value indicates that the model generalized well to unseen data and that the combination of gratitude, meaning in life, self-compassion, and resilience captured a substantial

portion of the psychological variance underlying life satisfaction. This is important because psychological well-being is rarely determined by purely linear or isolated effects. Instead, predictors may interact in nonlinear ways, and the strength of one resource may depend on the presence of another. For example, gratitude may produce stronger benefits when accompanied by resilience, and meaning in life may support life satisfaction more effectively when individuals are also self-compassionate. Prior research on positive psychology interventions supports this integrated interpretation, showing that well-being can be enhanced through combinations of mindfulness, gratitude, compassion, spirituality, and adaptive cognition (Basurrah, Baddar, et al., 2022; Basurrah, Blasi, et al., 2022; George et al., 2021). Digital intervention research also supports the feasibility of modeling and targeting multiple positive psychological constructs in scalable ways (Saboor et al., 2024). Thus, the neural network approach used in this study appears appropriate for examining the complex structure of life satisfaction.

The findings also support the broader view that life satisfaction is shaped by intentional cognitive-emotional practices and adaptive orientations toward experience. Studies on mindfulness programs for adolescents show that subjective well-being can be improved through practices that enhance awareness and engagement with the present moment (Primasari & Yuniarti, 2021). Similarly, the prioritization of positivity has been examined as a psychological tendency that may influence how individuals attend to and organize positive experiences in daily life (Machlah & Zięba, 2021). Cognitive strategies, including Stoic approaches to professional development, also emphasize the importance of interpretation, emotional discipline, and value-based response to difficult circumstances (Schimmels et al., 2024). Even outside traditional mental health contexts, mindfulness and adaptive awareness have been applied to complex social and ecological challenges, showing that psychological practices can influence how individuals relate to uncertainty, responsibility, and collective well-being (Gerber et al., 2023). The present findings are consistent with these perspectives because gratitude, meaning, self-compassion, and resilience all involve adaptive ways of attending to, interpreting, and responding to life experiences.

5. Conclusion

Overall, the results indicate that life satisfaction among adults in Germany can be predicted with high accuracy from a set of interrelated positive psychological resources. Resilience was the most influential predictor, suggesting that adaptive coping and recovery from adversity are central to life evaluation. Self-compassion was the second strongest predictor, indicating that emotional self-acceptance and reduced self-criticism are highly relevant to subjective well-being. Meaning in life contributed substantially by providing coherence, purpose, and existential direction, while gratitude added an appreciative and positive orientation toward life experiences. These findings extend previous research by demonstrating that these variables are not only correlated with well-being but also jointly capable of producing a strong predictive model when analyzed through artificial neural networks. The study therefore supports an integrated positive psychology framework in which life satisfaction is understood as the outcome of adaptive coping, compassionate self-relation, existential meaning, and grateful awareness.

6. Limitations & Suggestions

The present study has several limitations. First, the cross-sectional design limits causal interpretation, meaning that the results show predictive associations but cannot determine whether gratitude, meaning in life, self-compassion, and resilience directly cause increases in life satisfaction. Second, the data were collected through self-report questionnaires, which may be influenced by social desirability, response style, mood at the time of participation, and individual differences in self-awareness. Third, although the sample size was adequate for artificial neural network modeling, the use of a convenience-based recruitment strategy may limit the generalizability of the findings to all adults in Germany. Fourth, the model included four theoretically important predictors, but other relevant variables such as personality traits, social support, physical health, socioeconomic status, employment quality, loneliness, and cultural values were not included. Fifth, although artificial neural networks provide strong predictive capacity, they are less transparent than traditional statistical models, and even with feature-importance techniques, interpretation remains partly dependent on model-specific assumptions.

Future research should use longitudinal and experimental designs to clarify the directionality and causal mechanisms

linking gratitude, meaning in life, self-compassion, resilience, and life satisfaction. Studies could examine whether increases in these psychological resources over time lead to measurable improvements in life satisfaction and whether changes in one construct influence the others. Future studies should also test the model in different cultural, occupational, and age groups to determine whether the same predictive structure applies across diverse populations. In addition, researchers may compare artificial neural networks with other machine learning algorithms such as random forests, gradient boosting, support vector regression, and ensemble models to identify the most accurate and interpretable predictive approach. Future work could also include additional psychological, social, behavioral, and biological variables to develop more comprehensive models of well-being. Finally, mixed-methods studies may help explain how individuals subjectively experience gratitude, meaning, self-compassion, and resilience in daily life and how these experiences shape their evaluations of life satisfaction.

From a practical perspective, the findings suggest that interventions designed to improve life satisfaction should not focus on a single psychological strength in isolation. Programs for adults may be more effective when they combine resilience training, self-compassion exercises, meaning-centered reflection, and gratitude practices. Practitioners in counseling, coaching, health psychology, workplace well-being, and community mental health can use these findings to design multidimensional well-being programs that help individuals cope with adversity, reduce self-criticism, clarify personal values, and strengthen appreciation for positive aspects of life. Because resilience and self-compassion showed the greatest predictive importance, interventions may begin by helping individuals develop adaptive coping strategies and a kinder internal dialogue, then incorporate meaning-oriented and gratitude-based practices to deepen subjective well-being. In organizational and educational contexts, screening and support programs may also use these constructs to identify individuals who may benefit from preventive well-being interventions before psychological distress becomes more severe.

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Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

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All authors equally contributed in this article.

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References

- Basurrah, A. A., Baddar, M. K. A., & Blasi, Z. D. (2022). Positive Psychology Interventions as an Opportunity in Arab Countries to Promoting Well-Being. *Frontiers in psychology*, 12. <https://doi.org/10.3389/fpsyg.2021.793608>
- Basurrah, A. A., Blasi, Z. D., Lambert, L., Murphy, M., Warren, M. A., Setti, A., Baddar, M. K. A., & Shrestha, T. (2022). The Effects of Positive Psychology Interventions in Arab Countries: A Systematic Review. *Applied Psychology Health and Well-Being*, 15(2), 803-821. <https://doi.org/10.1111/aphw.12391>
- Baysal, M. (2022). Positive Psychology and Spirituality: A Review Study. *Spiritual Psychology and Counseling*, 7(3), 359-388. <https://doi.org/10.37898/spc.2022.7.3.179>
- Bluth, K., Knox, M. C., Press, A., & Lathren, C. (2023). Feasibility, Acceptability and Preliminary Outcomes of <i>Embracing Your Life: An Online Self-Compassion Program for Emerging Adults</i>. *Emerging Adulthood*, 11(5), 1281-1291. <https://doi.org/10.1177/21676968231189902>
- Bryan, S., & Hamilton, M. (2024). An Overview of Gratitude as a Mind-Body-Spirit Practice in Optimizing Health and Human Functioning. *Obm Integrative and Complementary Medicine*, 09(01), 1-19. <https://doi.org/10.21926/obm.icm.2401008>
- Calleja, P., Knight, P. A., McVicar, A., Laker, C., Yu, S., & Roszak-Burton, L. (2024). Gratitude Interventions to Improve Wellbeing and Resilience of Graduate Nurses Transitioning to Practice: A Scoping Review. *International Journal of Nursing Studies Advances*, 6, 100188. <https://doi.org/10.1016/j.ijnsa.2024.100188>
- Desai, K., O'Malley, P. A., & Culin, E. V. (2024). Impact of Heartfulness Meditation Practice Compared to the Gratitude Practices on Wellbeing and Work Engagement Among Healthcare Professionals: Randomized Trial. *PLoS One*, 19(6), e0304093. <https://doi.org/10.1371/journal.pone.0304093>
- George, A. J., Romate, J., & Rajkumar, E. (2021). Mindfulness-Based Positive Psychology Interventions: A Systematic Review. *BMC psychology*, 9(1). <https://doi.org/10.1186/s40359-021-00618-2>
- Gerber, L. R., Reeves-Blurton, Z., Gueci, N., Iacona, G. D., Beaudette, J. A., & Pipe, T. (2023). Practicing Mindfulness in Addressing the Biodiversity Crisis. *Conservation Science and Practice*, 5(7). <https://doi.org/10.1111/csp2.12945>
- Hobgood, C., & Jarman, A. F. (2024). Resilience Building Practices for Women Physicians. *Journal of Women S Health*, 33(4), 532-541. <https://doi.org/10.1089/jwh.2022.0502>
- John, E. S., Armstrong, L. L., & Watt, E. (2024). Meaning as an Early Determinant of Mental Health in Children. *The Humanistic Psychologist*, 52(2), 186-205. <https://doi.org/10.1037/hum0000328>
- Kumar, S. A., Edwards, M. E., Grandgenett, H. M., Scherer, L. L., DiLillo, D., & Jaffe, A. E. (2022). Does Gratitude Promote Resilience During a Pandemic? An Examination of Mental Health and Positivity at the Onset of COVID-19. *Journal of Happiness Studies*, 23(7), 3463-3483. <https://doi.org/10.1007/s10902-022-00554-x>
- Lawrence, A., Alkozei, A., Irgens, M. S., Acevedo-Molina, M. C., Brener, S. A., Chandler, A. B., Chau, R. F., Doyle, C., McKinney, A., Price, S. N., Shanholtz, C. E., Etten, E. J. V., Hoeve, E. S. V., Sbarra, D. A., & O'Connor, M.-F. (2021). Think Again: Adaptive Repetitive Thought as a Transdiagnostic Treatment for Individuals Predisposed to Repetitive Thinking Styles. *Journal of Psychotherapy Integration*, 31(2), 208-222. <https://doi.org/10.1037/int0000209>
- Machlah, J., & Zięba, M. (2021). Prioritizing Positivity Scale: Psychometric Properties of the Polish Adaptation (PPS-PL). *Roczniki Psychologiczne*, 24(2), 159-172. <https://doi.org/10.18290/rpsych21242-2>
- Mallon, A., Mitchell, G., Carter, G., McLaughlin, D., & Wilson, C. B. (2023). A Rapid Review of Evaluated Interventions to Inform the Development of a Resource to Support the Resilience of Care Home Nurses. *BMC Geriatrics*, 23(1). <https://doi.org/10.1186/s12877-023-03860-y>
- Maragha, T., Garcia, A. P., Shuler, C. F., & Bergmann, H. v. (2023). The Six-domain Well-being Framework in Oral Health Sciences: A Pathway From Theory to Practice. *Journal of Dental Education*, 88(2), 157-168. <https://doi.org/10.1002/jdd.13401>
- Maumus, M. (2022). Gratitude and Suicide. *Ochsner Journal*, 22(1), 3-5. <https://doi.org/10.31486/toj.22.0010>
- Merlo, G., Snellman, L., & Sugden, S. G. (2025). Connectedness: The Updated and Expanded Pillar of Lifestyle Psychiatry and Lifestyle Medicine. *American Journal of Lifestyle Medicine*, 19(8), 1104-1124. <https://doi.org/10.1177/15598276251345455>
- Mogeda El Sayed El, K., & Sarour, E. O. (2024). The Relationships Between Work-Family Conflict and Life Satisfaction and Happiness Among Nurses: A Moderated Mediation Model of Gratitude and Self-Compassion. *Frontiers in Public Health*, 12. <https://doi.org/10.3389/fpubh.2024.1340074>

- Pagani, L. S., Kazandjian, N., Geoffrion, S., & Barnett, T. A. (2025). Early Adulthood and Care Giving Professions in the 21st Century: Mental Wellness as an Institutional Priority and Reward Strategy. *Inquiry the Journal of Health Care Organization Provision and Financing*, 62. <https://doi.org/10.1177/00469580251399302>
- Pahwa, S., & Khan, N. (2022). Factors Affecting Emotional Resilience in Adults. *Management and Labour Studies*, 47(2), 216-232. <https://doi.org/10.1177/0258042x211072935>
- Peterson, N. E., Thomas, M. C., Hunsaker, S., Stewart, T. H. M., & Collett, C. J. (2024). mHealth Gratitude Exercise Mindfulness App for Resiliency Among Neonatal Intensive Care Unit Staff: Three-Arm Pretest-Posttest Interventional Study. *Jmir Nursing*, 7, e54561. <https://doi.org/10.2196/54561>
- Primasari, A., & Yuniarti, K. W. (2021). Enjoying Every Moment: Improving Adolescent's Subjective Well-Being Through Adolescent Mindfulness Program. *Gadjah Mada Journal of Professional Psychology (Gamajpp)*, 7(2), 115. <https://doi.org/10.22146/gamajpp.65594>
- Robbins, B. D. (2021). The Joyful Life: An Existential-Humanistic Approach to Positive Psychology in the Time of a Pandemic. *Frontiers in psychology*, 12. <https://doi.org/10.3389/fpsyg.2021.648600>
- Saboor, S., Medina, A., & Marciano, L. (2024). Application of Positive Psychology in Digital Interventions for Children, Adolescents, and Young Adults: Systematic Review and Meta-Analysis of Controlled Trials. *Jmir Mental Health*, 11, e56045. <https://doi.org/10.2196/56045>
- Schimmels, J., Schneider, J., Bücher, K., & Coty, M. B. (2024). Stoicism and Cognitive Strategies for Nursing Professional Development. *The Journal of Continuing Education in Nursing*, 55(8), 378-386. <https://doi.org/10.3928/00220124-20240328-02>
- Wei, H., Hardin, S. R., & Watson, J. (2021). A Unitary Caring Science Resilience-Building Model: Unifying the Human Caring Theory and Research-Informed Psychology and Neuroscience Evidence. *International journal of nursing sciences*, 8(1), 130-135. <https://doi.org/10.1016/j.ijnss.2020.11.003>
- You, M., & Kim, E.-J. (2025). Effects of Gratitude Journaling on Patients With Breast Cancer: A Randomized Controlled Trial. *Current Oncology*, 32(7), 400. <https://doi.org/10.3390/curroncol32070400>
- Zhang, H., & Li, Y. (2021). Child Neglect and Life Satisfaction Among Left-Behind Children in Rural China: The Roles of Self-Compassion and Gratitude. *Journal of interpersonal violence*, 37(17-18), NP15649-NP15669. <https://doi.org/10.1177/08862605211016348>