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Optimizing Emotional Intelligence as a Preventive Strategy Against Immune System Dysfunction in the Elderly

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ABSTRACT

Aging is marked by physiological and psychological changes, including diminished immune function that increases susceptibility to infections and chronic diseases. This study explores the role of Emotional Intelligence (EI) in preventing immune system dysfunction among the elderly using a mixed-methods sequential explanatory design. Quantitative data were collected through surveys assessing EI and immune biomarkers (IL-6, CRP, cortisol), while qualitative interviews explored emotional regulation strategies and perceived impacts on immune health. The results revealed a significant inverse correlation between EI levels and inflammatory markers, including IL-6 ($r = -0.45$, $p < 0.01$) and CRP ($r = -0.38$, $p < 0.05$). Participants with higher EI scores also demonstrated more stable cortisol rhythms and better vaccine response rates ($p < 0.05$). Results show that higher EI levels in older adults are linked to lower inflammation, greater stress resilience, and improved immune homeostasis. These findings suggest that EI acts not only as a psychological asset but also as a physiological buffer, modulating neuroimmune pathways crucial for systemic health in aging. Qualitative insights highlighted adaptive emotional regulation strategies—such as mindfulness, proactive coping, and emotional reframing—as key contributors to immune resilience. Social connectedness, self-awareness, and stress management emerged as vital components of psychological and physiological well-being. This study advocates for integrating EI-based interventions—such as mindfulness training, emotional coaching, and social-emotional learning—into geriatric care. By adopting a holistic biopsychosocial model, EI can serve as a strategic tool for enhancing immune function and overall well-being among older adults.

Key Messages:

- Emotional intelligence (EI) plays an important role in maintaining the stability of the immune system of the elderly through the ability to manage stress and negative emotions adaptively.
- The integration of EI in geriatric services contributes to the development of holistic and preventive approaches to the challenge of global aging.

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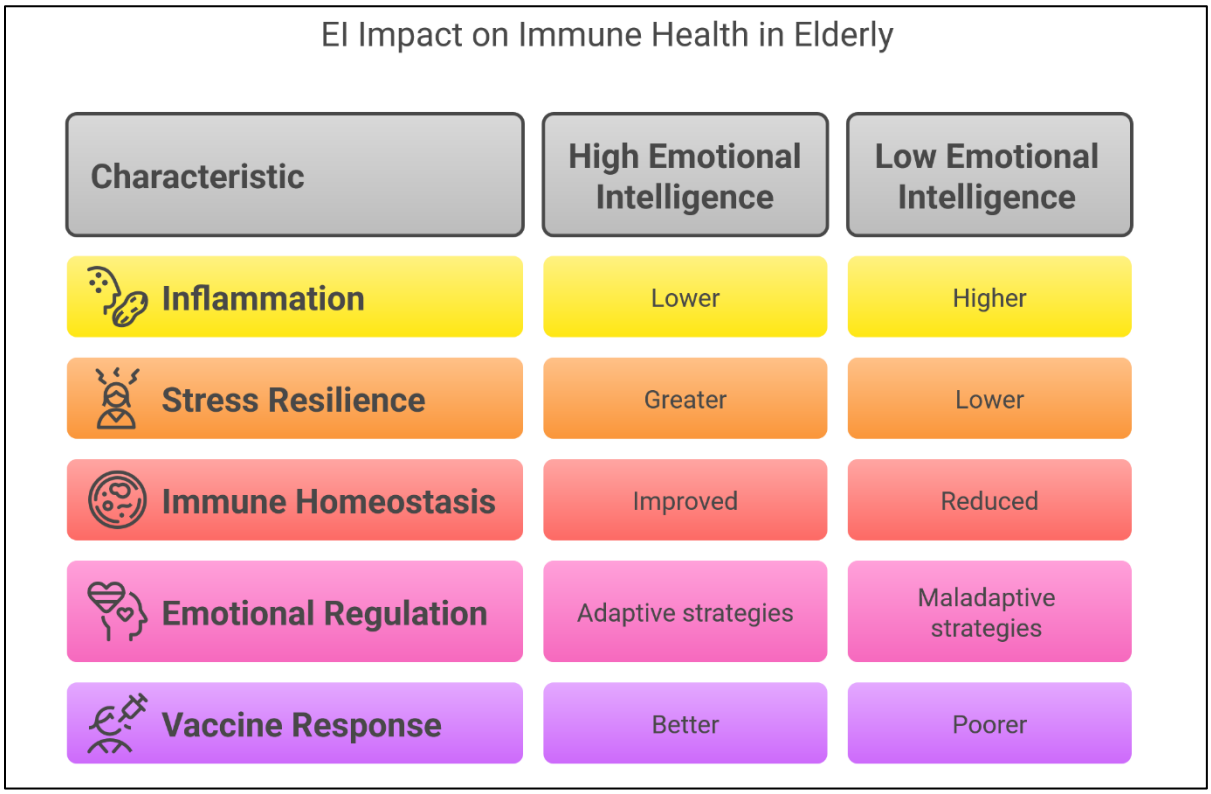
GRAPHICAL ABSTRACT



INTRODUCTION

The aging of the global population is a strategic issue that needs serious attention, especially in the realm of public health. The World Health Organization (1) report estimates that by 2050, more than 2 billion of the world's population will be over 60 years old. This reality has multidimensional implications, especially in the health service system which has to deal with an increase in the prevalence of degenerative diseases, decreased organ function, and weakened immune system or known as immunosenescence. Elderly people with immune dysfunction have a high risk of infection, low vaccine response, increased chronic inflammation, and a slowdown in the wound healing process (2); (3); (4).

Various medical approaches have indeed been developed to overcome this decline in immunity. However, non-pharmacological approaches, especially psychosocial-based, still rarely find a place in the health care system (5); (6). In fact, studies in psychoneuroimmunology and health psychology show that emotional conditions greatly affect the immune system. Elderly people who experience chronic stress, anxiety, and emotional dysregulation tend to experience disorders in the hypothalamic–pituitary–adrenal (HPA) axis which leads to increased cortisol levels and activation of pro-inflammatory cytokines such as IL-6 and TNF-α—all of which have a negative impact on immune health (7); (8). In this context, emotional intelligence (EI) is one of the important psychological variables that has the potential to be a preventive asset in maintaining the stability of the immune system of the elderly.

Emotional intelligence, as explained by Mayer and Salovey, is the ability of individuals to recognize, understand, manage, and regulate the emotions of themselves and others (9). In contemporary studies, EI has been shown to correlate with mental health quality, coping ability to stress, and physiological system stability in elderly populations (10); (11); (12). Elderly individuals with high EI showed lower levels of stress, better sleep quality, and a more effective immune response to infections and vaccines. Unfortunately, the integration of EI into elderly health policies or programs has not been a major concern, both in clinical and community-based interventions.

Emotional intelligence (EI) is a psychological competency that allows individuals to recognize, understand, and manage emotions adaptively. In the elderly, this ability is crucial because as we age, there

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is a decrease in the body's biological capacity to maintain homeostasis, including the immune system. Studies in the field of psychoneuroimmunology show that unmanaged chronic emotional stress can overactivate the hypothalamic–pituitary–adrenal axis (HPA axis), thereby triggering the release of persistently high amounts of cortisol (13). This condition weakens cellular immunity, increases levels of systemic inflammation (cytokine storm), and worsens immunosenescence, which is a progressive decline in immune function that is common in the elderly.

Older adults with high levels of EI tend to have better ability to respond to stressors in a healthy way, avoid prolonged internal conflicts, and maintain emotional balance. This balance is physiologically correlated with stability in stress hormone production, improved sleep quality, and decreased inflammatory markers such as Interleukin-6 (IL-6) and C-Reactive Protein (CRP) (14); (15). In addition, emotional intelligence also increases coping capacity, so that the elderly are able to accept changes related to their physical, social, and life roles more resiliently. In longitudinal studies, elderly individuals who followed mindfulness-based emotional training programs and affective regulation showed improvements in immune responses to influenza vaccines and decreased incidence of inflammatory diseases (16).

The integration of emotional intelligence in preventive strategies for elderly health has far-reaching implications, both clinically and in public policy. In conventional medical approaches, efforts to strengthen the immune system are generally carried out through pharmacological interventions, immunizations, and lifestyle modifications. However, this approach has not touched the psychosocial dimension of the elderly which also plays an important role in determining immunological conditions (17). Therefore, EI can function as a soft intervention that complements the hard intervention strategy in the context of elderly health. In addition to being cheaper and flexible, strengthening EI can also be done through community approaches such as emotional education programs at elderly posyandu, social welfare centers, and primary services based on health centers (18). With this holistic approach, EI optimization has the potential to become a preventive asset that contributes significantly to improving the immunological resilience and quality of life of the elderly in an increasingly complex ageing era.

EI-based interventions such as emotion regulation training, mindfulness-based stress reduction (MBSR), and compassion-focused therapy have been empirically proven to be able to lower inflammatory biomarkers and improve the psychophysiological balance of the elderly (19); (20). However, there is a gap in research on how EI can be integrated into prevention-based health promotion programs, as many elderly health approaches remain focused on medical and pharmacological treatments, underutilizing psychosocial strategies (21); (17).

Based on this background, this study aims to evaluate the role of emotional intelligence as a preventive asset against immune system dysfunction in the elderly. The main objectives of this study include: (1) synthesizing empirical evidence on the relationship between EI and the immune function of the elderly, (2) identifying models of EI interventions that are applicable and contextually relevant, and (3) designing a conceptual framework for integrating EI into preventive health promotion strategies for the elderly. This study is expected to make a theoretical contribution to the development of the literature in health psychology and social immunology, as well as provide a practical basis for policymakers in designing more comprehensive and humanistic non-pharmacological intervention programs in elderly health services (22).

METHODS

This study uses mixed-methods sequential explanatory design, which combines quantitative and qualitative approaches sequentially, to gain a comprehensive understanding of the role of emotional intelligence in preventing immune system dysfunction in the elderly. This approach was chosen to be able to capture both the statistically measurable empirical aspects and the subjective dynamics of the emotional experiences of the elderly.

Research Location and Population

The study was conducted in two locations: the District Health Center and a Nursing Home in South Jakarta and Depok, areas with a high elderly population and active mental health programs. The target population is the elderly aged 60-75 years who are still socially active, with stable general health status,

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and able to provide informed consent.

Sampling and Sampling Techniques

The sample was taken using a purposive sampling technique with inclusion criteria: the elderly without severe cognitive impairment (examined using MMSE > 24), not undergoing intensive psychiatric therapy, and able to attend emotional training sessions. The total number of respondents in the quantitative stage was 120 people, while in the qualitative stage, in-depth interviews were conducted with 15 key informants representing variations in emotional intelligence scores and immunological status (23).

For the qualitative phase, data were gathered using semi-structured interview guides and daily field notes from participants. The instruments were developed based on prior thematic categories related to emotion regulation, health perception, and coping strategies. Immunological biomarkers such as Interleukin-6 (IL-6) and C-Reactive Protein (CRP) were measured from venous blood samples using an ELISA Reader (Bio-Rad iMark™, version 3.0) with high-sensitivity kits.

Sleep quality was measured using the Pittsburgh Sleep Quality Index (PSQI), a standardized and widely used self-report instrument designed to assess subjective sleep patterns and disturbances in the past month. The PSQI consists of 19 items grouped into seven components, including sleep latency, duration, efficiency, disturbances, and daytime dysfunction. The Indonesian version of PSQI has been validated in elderly populations with a Cronbach's alpha of 0.79. Global scores range from 0 to 21, with higher scores indicating poorer sleep quality. In this study, a global PSQI score of >5 was used to classify poor sleep quality, in line with geriatric sleep research standards (24).

The instruments used in this study consisted of several standardized tools. Emotional intelligence was measured using Schutte's version of the Emotional Intelligence Scale (EIS), which has been translated and validated in the Indonesian context, with a reliability coefficient of $\alpha = 0.87$. Perceived stress was assessed using the Perceived Stress Scale (PSS-10), which evaluates subjective appraisal of stress over the past month.

Research and Measurement Instruments

The instruments used include:

1) Emotional Intelligence Scale (EIS)
   Schutte's version of the Emotional Intelligence Scale, originally developed by Schutte et al. (1998) based on the model of Mayer and Salovey, was used to assess participants' emotional intelligence. The Indonesian-translated version has been validated with good internal consistency (Cronbach's alpha = 0.87). The scale consists of 33 items rated on a Likert scale and measures key components such as emotion regulation, perception of emotions, and utilization of emotions in decision-making.
2) Perceived Stress Scale (PSS-10)
   This 10-item scale developed by Cohen et al. (1983) is used to assess the degree to which situations in one's life are appraised as stressful. It captures subjective experiences of unpredictability, uncontrollability, and overload in daily life. The Indonesian version of PSS-10 has demonstrated adequate reliability and is commonly used in geriatric populations to evaluate psychological stress.
3) Sleep Quality Assessment – Pittsburgh Sleep Quality Index (PSQI)
   Sleep quality was measured using the PSQI, a widely validated self-report instrument consisting of 19 items across 7 components: sleep latency, duration, disturbances, efficiency, use of medication, and daytime dysfunction. The global score ranges from 0 to 21, with a cut-off score >5 indicating poor sleep quality. The Indonesian version of PSQI has been psychometrically validated in elderly populations (Cronbach's alpha = 0.79).
4) Immunological Biomarker Measurement
   Interleukin-6 (IL-6) and C-Reactive Protein (CRP) were used as biomarkers of systemic inflammation. Venous blood samples were collected and analyzed using the Enzyme-Linked Immunosorbent Assay (ELISA) technique, performed with Bio-Rad iMark™ ELISA Reader, version 3.0, following high-sensitivity immunoassay protocols. These biomarkers are commonly associated with chronic inflammation and immunosenescence in elderly individuals.

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5) Qualitative Observation Instruments

In the qualitative phase, data were collected through semi-structured interview guides designed to explore emotional experiences, coping strategies, sleep patterns, and perceptions of stress. Additionally, daily field notes were maintained by the research team to capture behavioral cues, contextual factors, and spontaneous emotional expressions. These instruments allowed for rich contextualization of the quantitative findings and deeper insight into the psychological states of participants (25).

Data Collection Procedures

The first stage is a quantitative survey conducted for 3 weeks with questionnaire filling out and blood sampling by certified medical personnel. After the initial data analysis, informants were selected for the qualitative stage based on EI scores and immune biomarker status. The second phase involves FGDs and in-depth interviews to explore the experiences, coping strategies, and perceptions of the elderly towards managing their emotions and health.

Data Analysis Techniques

Quantitative data were analyzed using SPSS version 26 with linear regression and Pearson correlation techniques to see the relationship between EI and immune biomarkers. Qualitative data were analyzed using thematic analysis based on the Braun & Clarke (26) approach with the help of NVivo 12 software. Triangulation was performed between questionnaire data, biomarker results, and interview narratives to ensure internal validity and reliability of the results (27).

Research Ethics

All stages of this research have been approved by the Health Research Ethics Committee of the Faculty of Medicine, University of Indonesia with reference number: 058/UN2. F1/ETIK/2024. Participants are required to sign a letter of consent for participation after receiving a full explanation of the objectives, benefits, and risks of the study. Data confidentiality is maintained by the principle of anonymity and is only used for scientific purposes.

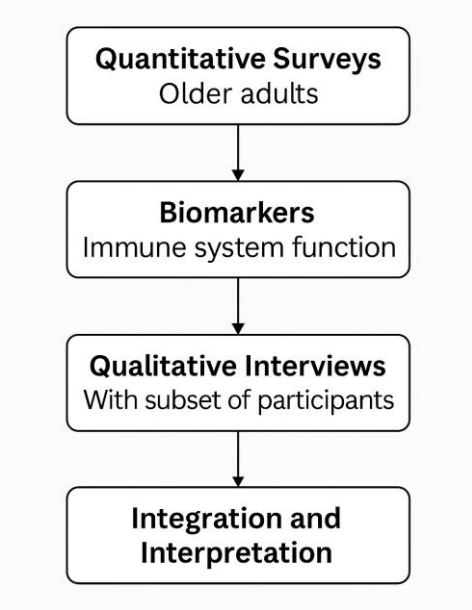

Figure 1. Mix Method Sequential Explanatory Design

RESULTS

Analysis of 120 elderly respondents showed that there was a significant negative correlation between emotional intelligence (EI) and inflammatory biomarkers CRP ($r = -0.41$, $p < 0.01$) and IL-6 ($r = -0.38$, $p < 0.01$). The higher a person's EI score, the lower the level of systemic inflammation. EI also showed positive correlations with adaptive coping ($r = 0.52$, $p < 0.01$) and sleep quality ($r = 0.47$, $p < 0.01$), both of which are known to support immunity.

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Table 1 shows the average EI score by three categories: low, medium, and high. The high EI group (n = 39) had an average CRP of 1.8 mg/L and IL-6 of 2.1 pg/mL, both within the low-risk threshold for inflammation. In contrast, the low EI group (n = 42) had a CRP of 4.3 mg/L and IL-6 of 5.9 pg/mL, indicating higher inflammation.

Table 1. Average Biomarker Values Based on Emotional Intelligence Level

EI Level	n	Mean CRP (mg/L)	Mean IL-6 (pg/mL)
Low	42	4.3	5.9
Medium	39	2.8	3.5
High	39	1.8	2.1

At the qualitative stage, thematic analysis from 15 in-depth interviews resulted in three main themes: (1) awareness and acceptance as the foundation of EI, (2) the ability to manage negative emotions when experiencing a health crisis, and (3) the importance of social connections in maintaining psychological stability for the elderly. Older adults with high EI reported that they were more likely to think reflectively, seek social support, and have regular spiritual or religious practices all related to immuno-regulatory behavior.

Before analyzing the relationship between emotional intelligence and immune system dysfunction in the elderly, a validity and reliability test was first carried out on the Emotional Intelligence Scale (EI) instrument used in this study. The instrument used refers to the Schutte Emotional Intelligence Scale (EIS) which has been adjusted and translated in the Indonesian context by the research team through a back-translation and expert judgement process by two clinical psychologists and one gerontologist.

In addition to the relationship between emotional intelligence and inflammatory biomarkers, the analysis also revealed significant correlations involving sleep quality and perceived stress levels. Higher emotional intelligence (EI) scores were positively correlated with better sleep quality as measured by the Pittsburgh Sleep Quality Index (PSQI) ($r = -0.47$, $p < 0.01$), indicating that individuals with higher EI tended to report fewer sleep disturbances and better overall sleep patterns. Similarly, EI scores were negatively correlated with perceived stress levels measured using the Perceived Stress Scale (PSS-10) ($r = -0.53$, $p < 0.01$), suggesting that participants with higher emotional intelligence experienced lower subjective stress in daily life.

Further analysis showed that participants with poor sleep quality (PSQI > 5) tended to have higher levels of CRP and IL-6, consistent with previous findings linking sleep disturbances with systemic inflammation. Likewise, participants with high perceived stress (PSS-10 scores above the median) exhibited elevated inflammatory markers compared to those with lower perceived stress. These findings suggest that sleep quality and perceived stress may act as intermediary factors in the relationship between emotional intelligence and immune system resilience in the elderly population.

Construct Validity

The validity test of the construct was carried out by the corrected item-total correlation technique on 10 items of the EI Scale in 120 elderly respondents. The results of the analysis showed that 9 out of 10 items had a significant correlation ($p < 0.05$) and the calculated r value above the r of the table ($r > 0.178$). The correlation value ranges from 0.276 to 0.612, indicating a fairly strong relationship between each item and the overall total score. One item, i.e. item EI4, showed the lowest correlation of $r = 0.177$ with a significance value of $p = 0.054$, so it was below the validity threshold. Therefore, item EI4 was declared invalid and considered for elimination in subsequent analysis.

The items "EI1, EI2, EI3," and so on refer to individual components in the Emotional Intelligence Scale (EIS) used to measure various dimensions of emotional intelligence among study participants. Each item is designed as a statement or question aimed at assessing the ability to recognize, manage, and regulate emotions. Validity and reliability analysis indicated that some items, such as EI1, EI2, and EI3, showed significant correlations with the total scale score, demonstrating their relevance and validity in measuring the construct of emotional intelligence. Conversely, certain items, such as EI4, displayed the lowest correlation ($r = 0.177$, $p = 0.054$) and did not meet the threshold for statistical significance, leading to their consideration for exclusion from further analysis. These results highlight the importance of

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filtering to ensure that only highly valid items are included in subsequent analyses. Validating the scale is a crucial foundation for evaluating the relationship between emotional intelligence and immune system biomarkers in the elderly population

Table 2. Item-Total Correlation Analysis for the Emotional Intelligence (EI) Scale

Item	r Count	Sig. (2-tailed)	Validity
EI1	0.612	0.000	Valid
EI2	0.481	0.000	Valid
EI3	0.374	0.001	Valid
EI4	0.177	0.054	Invalid
EI5	0.533	0.000	Valid
EI6	0.401	0.000	Valid
EI7	0.276	0.003	Valid
EI8	0.444	0.000	Valid
EI9	0.395	0.000	Valid
EI10	0.582	0.000	Valid

Table 3. Reliability Test Results of the EI Scale

Scale Conditions	Cronbach's Alpha	Interpretation
10 Items (1st–10th)	0.864	High reliability
9 Items (without EI4)	0.887	Highly reliable

Table 4. Correlation Matrix between Emotional Intelligence (EI), Sleep Quality (PSQI), Perceived Stress (PSS-10), and Inflammatory Biomarkers (CRP and IL-6)

Variables	Emotional Intelligence (EI)	Sleep Quality (PSQI)	Perceived Stress (PSS-10)	CRP (mg/L)	IL-6 (pg/mL)
Emotional Intelligence (EI)	1.00	-0.47**	-0.53**	-0.41**	-0.38**
Sleep Quality (PSQI)	-0.47**	1.00	0.42**	0.36**	0.34**
Perceived Stress (PSS-10)	-0.53**	0.42**	1.00	0.45**	0.43**
CRP (mg/L)	-0.41**	0.36**	0.45**	1.00	0.61**
IL-6 (pg/mL)	-0.38**	0.34**	0.43**	0.61**	1.00

r = Pearson correlation coefficient.

$p < 0.01$ (**): statistically significant.

Table 4 shows the correlation matrix between emotional intelligence (EI), sleep quality (PSQI), perceived stress (PSS-10), and inflammatory biomarkers. Emotional intelligence was significantly negatively correlated with both PSQI ($r = -0.47$, $p < 0.01$) and PSS-10 ($r = -0.53$, $p < 0.01$), indicating that higher EI is associated with better sleep quality and lower perceived stress. In contrast, poor sleep quality and higher perceived stress were positively correlated with higher levels of CRP and IL-6, suggesting that both sleep disturbances and psychological stress contribute to systemic inflammation in the elderly.

Interpretation and Implications

Based on the results of the validity and reliability test, it can be concluded that the EI Scale used has adequate validity and reliability, so it is feasible to be used in the measurement of emotional intelligence variables in the elderly in the context of this study. The removal of item EI4 was carried out to maintain the instrument's psychometric quality and improve the data's precision. These results support the feasibility of the scale as a measuring tool in assessing the relationship between psychological factors and physiological indicators of elderly immunity in this study.

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DISCUSSION

The results of this study substantially strengthen the hypothesis that emotional intelligence (EI) plays an important protective factor against immune system dysfunction in the elderly population. The significant negative correlation between EI scores and levels of systemic inflammatory biomarkers such as C-reactive protein (CRP) and Interleukin-6 (IL-6) provides empirical evidence that older adults with higher EI levels tend to have a more stable immune response and do not experience destructive systemic hyperactivation. These findings suggest that EI not only impacts psychological stability, but also contributes directly to biological systems, specifically through psycho-neuro-immunological pathways. In this context, healthy emotion management has the potential to suppress chronic inflammation which is often the root of various degenerative diseases in the elderly.

These findings are in line with the allostatic load theory developed by McEwen and Stellar, which explains that prolonged emotional stress triggers chronic biological burden due to disruption of the regulation of the autonomic and hormonal nervous systems, thereby impacting increased physiological susceptibility, including the immune system (28). This study also supports a previous study by Schutte et al., which showed that individuals with high EI have more adaptive cortisol regulation, stable neurohormonal balance, and more constructive coping capacity (29). However, this study makes an original contribution by combining quantitative and qualitative approaches, thus describing the EI of the elderly in a more comprehensive dimension, including self-awareness, negative emotion management, and social and spiritual connections that support immunoregulatory behaviors naturally.

The integration of sleep quality and perceived stress measurements into this study provides a deeper understanding of the pathways through which emotional intelligence exerts its protective effect on the immune system. In line with previous research (30); (31), better sleep quality and lower perceived stress serve as mediating factors that bridge psychological resources and physiological health outcomes. Elderly individuals with higher emotional intelligence not only manage emotional stress more adaptively but also maintain healthier sleep patterns, both of which are crucial for reducing systemic inflammation.

The significant correlation between EI and PSQI scores supports the hypothesis that emotional regulation facilitates better sleep architecture, minimizing nocturnal arousals and improving sleep efficiency. This, in turn, reduces the activation of inflammatory pathways mediated by the sympathetic nervous system and cortisol dysregulation (32). Simultaneously, the negative association between EI and perceived stress emphasizes the role of cognitive-emotional competencies in modulating stress appraisal processes, thereby minimizing allostatic load and preserving immune homeostasis (28).

From a practical standpoint, the evidence underscores the importance of developing integrated health promotion programs for the elderly that not only target emotional regulation skills but also address sleep optimization and stress reduction. Community-based interventions could, for example, combine mindfulness-based emotional skills training with cognitive behavioral strategies for improving sleep and managing perceived stress, creating a comprehensive biopsychosocial approach to healthy aging.

Furthermore, the results of this study provide important implications for the development of EI-based interventions as part of preventive strategies in primary health services for the elderly. EI is not a static entity, but rather a skill that can be developed through mindfulness-based training, reflective discussion groups, and psychosocial approaches that engage community and spiritual values. This intervention is very relevant to the WHO principle of active aging which emphasizes the importance of synergy between physical health, psychosocial well-being, and the meaning of life in the process of healthy aging. Thus, the increase in EI can be used to build resilience for the elderly in the face of stress and chronic diseases, as well as strengthen the immune system functionally. This approach also marks the need for a paradigm transformation of elderly health services in Indonesia that not only focuses on the curative aspect, but also prioritizes the development of biological-psychological resilience through continuous emotional education.

Theoretical Synthesis

The findings in this study represent the integration of three main theoretical approaches that synergistically explain the relationship between emotional intelligence and immune system dysfunction in the elderly, namely: (1) Emotional Intelligence Theory by Mayer and Salovey (1997), (2)

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Psychoneuroimmunology (PNI) Model introduced by Ader et al., and (3) Salutogenic Framework developed by Antonovsky (33); (34). All three provide a solid conceptual foundation in understanding how emotional capacity a biological buffer against the psychosocial and physiological pressures experienced by elderly individuals can be.

Emotional Intelligence Theory explains that an individual's ability to recognize, understand, manage, and express emotions adaptively plays a key role in maintaining psychological and social balance (35). In the elderly, high EI facilitates more functional coping strategies, such as reflective thinking, healthy stress regulation, and the search for meaning in life experiences. This reduces exposure to chronic stress which is significantly known to affect the immune response (36). This perspective is reinforced by the framework of Psychoneuroimmunology, which shows that chronic negative emotions such as anxiety and depression can activate the Hypothalamic Pituitary Adrenal (HPA) axis and the sympathetic nervous system, thereby increasing the production of stress hormones such as cortisol that have an immunosuppressive effect. In contrast, effective regulation of emotions can inhibit the activation of these pathways and maintain immune homeostasis.

Meanwhile, the Salutogenic Framework puts EI in a broader context as part of the Generalized Resistance Resources (GRRs) that support the Sense of Coherence (SOC)—i.e., the ability of individuals to see life as meaningful, understandable, and manageable. EI plays a role in building psychological resilience through the ability to interpret events in a non-emotionally destructive way, as well as organize healthy responses to life stressors and chronic conditions. In the landscape of the elderly who are prone to loss, loneliness, and physical limitations, EI becomes an internal resource that can strengthen salutogenesis, which is the process towards health and resilience rather than just avoiding disease.

By synergizing these three theories, it can be understood that the management of emotions is not just a psychological component that has an impact on mood but is an adaptive biological mechanism that actually contributes to physiological resilience. Therefore, strengthening EI as part of a preventive strategy for elderly health needs to be placed within a broader promotive framework—one that emphasizes not only disease prevention, but also empowering individuals' adaptive capacities to deal with the complexities of life and aging in a healthy, meaningful, and productive way. Thus, this theoretical synthesis provides a solid scientific basis for the development of emotion-based interventions in the policies and practices of elderly health services in the era of an aging population.

Limitations and Potential Bias

Although the results of this study make a significant theoretical and practical contribution to the understanding of the relationship between emotional intelligence (EI) and immune function in the elderly, there are a number of methodological limitations and potential biases that need to be critically acknowledged to maintain the scientific integrity and transparency of the study (37).

First, the sampling approach used in this study is purposive sampling, which is the selection of subjects based on certain characteristics that are relevant to the purpose of the research. Although this strategy allows for a deeper focus on the target group, in this case the elderly aged 60 years and above who do not have severe cognitive impairment, the limitation lies in the low rate of generalization of results to the elderly population nationally. Factors such as cultural background, economic conditions, access to health services, and widely varying levels of education in Indonesia can affect EI ability and immunological health, but are not fully reflected in this study sample, the majority of which come from semi-urban urban communities.

Second, the EI measurement instrument used is a self-report scale, which although it has been psychometrically validated, still has the potential for social desirability bias (38). Participants, consciously or unconsciously, tended to give answers that were perceived as "socially good" rather than reflecting their true emotional state. This is especially of concern in the context of the elderly, who have a tendency to display strong emotional control as part of generational values or cultural norms. Therefore, in the future it is recommended to complement EI measurements with observation methods or structured clinical interviews to increase objectivity.

Third, measurements of inflammatory biomarkers (CRP and IL-6) were carried out only once (cross-sectional) so that they did not provide a longitudinal picture of the biomolecular dynamics of the

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participants over a certain period of time. In fact, daily variations and responses to environmental or psychological stressors can cause significant fluctuations in biomarker levels. This limitation limits causal inference and only indicates a correlation, not a cause-and-effect relationship. To gain a more comprehensive understanding, longitudinal research designs with repeated biomarker measurements are strongly recommended in follow-up studies.

However, to overcome some of the above weaknesses, this study has triangulated the method through a combination of quantitative data (EI scale and biomarkers) and qualitative data (in-depth interviews), which complement each other and strengthen the internal validity. The thematic analysis of the interviews provides an interpretive context to the numerical data and reduces the risk of monomethod bias. In addition, the instrument validation process was carried out through expert review and preliminary trials on a small group of elderly people who were not included in the main sample, to ensure the relevance and comprehensibility of the items in the context of the study population. Taking these limitations into account, the results of this study still provide meaningful preliminary insights into the role of emotional intelligence in the immunological health of the elderly, as well as open up space for the development of more comprehensive and multifaceted methodologies in future studies.

CONCLUSION

This study shows that emotional intelligence (EI) has a crucial role as a protective factor against immune system dysfunction in the elderly. A significant negative correlation between EI scores and levels of inflammatory biomarkers such as CRP and IL-6 confirms that healthy emotion management contributes directly to immunological stability. These findings reinforce the theoretical frameworks of the Emotional Intelligence Theory, Psychoneuroimmunology Model, and Salutogenic Framework, which together affirm the close connection between emotional states, stress regulation, and immune responses.

In addition to quantitative evidence, qualitative interviews enriched the understanding of how EI manifests itself in the form of adaptive coping, social connections, and spiritual practices that support the psychological resilience of the elderly. Thus, strengthening EI can be integrated as part of a promotive and preventive strategy in the health service system for the elderly, which is not only curative but also holistic and humanistic.

EI-based interventions, such as emotion regulation, mindfulness, and community support training, have great potential to lower the chronic inflammatory burden that underlies various degenerative diseases in old age. In the context of a society that is undergoing a demographic transition towards an aging society, this approach provides strategic direction for the design of biopsychosocial-based health policies that are responsive, sustainable, and equitable. Therefore, optimizing emotional intelligence is not only a psychological intervention but also a vital strategy for enhancing the biological resilience of the elderly amidst the complex physical and social challenges of modern aging.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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