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Article

The biomechanical impact of ecotourism's role in promoting health and biodiversity conservation among tourists

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Abstract: The potential of ecotourism to support visitor health and biodiversity conservation is becoming more widely acknowledged. With an emphasis on the significance of biodiversity protection, this study investigates how ecotourism affects visitors' physical and emotional health among tourists, with a specific focus on the biomechanical aspects of movement and physical activity in natural environments. Data were collected from 685 tourists who engaged in ecotourism activities at sites with significant biodiversity. Structured questionnaires were used to measure self-reported health indicators, such as mental well-being, physical activity levels, stress reduction, social bonding, and biodiversity awareness. Descriptive statistics, Pearson's correlation, *t*-tests, multiple regression analysis, and analysis of variance (ANOVA) were used to analyze. to evaluate the relationships between biodiversity exposure and health outcomes. While Pearson's correlation analyzes the degree of linear connection between factors, descriptive statistics highlight important aspects of the data. ANOVA and *t*-tests are used to evaluate group means; ANOVA handles a maximum of three groups, while t-tests concentrate on two. To forecast results, multiple regression analysis examines how several independent factors affect one dependent variable. The data in Statistical Package for the Social Sciences (SPSS) version 26 to investigate the connections between biodiversity exposure and health outcomes. The findings showed a strong positive relationship between exposure to biodiversity and gains in mental and physical health, underscoring the double advantages of ecotourism in raising awareness of conservation awareness and enhancing well-being. Additionally, the study underscores the importance of biomechanical factors, such as movement efficiency and physical exertion, which are enhanced through activities like hiking, kayaking, and wildlife observation in natural settings. These activities not only promote physical fitness but also contribute to mental health by reducing stress and improving mood through immersive experiences in nature. These results highlight how crucial it is to promote ecotourism as a renewable travel industry that promotes biodiversity preservation and personal well-being, integrating biomechanical principles to optimize physical activity and health outcomes.

Keywords: ecotourism; tourists' health; biodiversity conservation; biomechanics; physical and mental health; sustainable tourism practices and stress reduction

1. Introduction

Tourism promotes the exploration of nature, adventures, societies, cultures, ideals, and new customs. Tourism development involves attracting tourists to a destination to grow and sustain the tourism business [1]. Environmental sustainability entails preserving social and cultural traditions and biodiversity, protecting ecosystems, and improving the public's health and economic well-being [2]. Hygienic, greener natural planting, thriving biodiversity, dry fields, socio-cultural values, and historic legacy are all examples of environmental sustainability

[3]. These factors demonstrate the local community's motivation and willingness to welcome visitors comfortably. Ecotourism is becoming increasingly popular in regions with significant biodiversity because of its ability to benefit both rural life and environmental protection [4].

It has the potential to alleviate poverty, which is deeply ingrained in many parts of society. The TIES defines ecological tourism as moral travel to ecosystems that supports and enhances the health of local people and preserves the environment [5]. Eco-tourists are already classified as sustainable visitors; thus, this fact is being neglected. As a result, a cost-benefit analysis of nature-based tourism is crucial for wild and vulnerable areas, rather than merely organizing types of tourists or travelers as sustainable [6]. As the industry deals with growing environmental challenges, the significance of ecotourism extends beyond ecological restoration, providing capability fitness benefits that surely affect members' well-being [7].

Participating in nature-focused sports allows people to escape metropolitan stressors, increase physical fitness, and connect with nature, which may also foster intellectual readability and emotional resilience. The relationship between biodiversity and human health has received increased research attention [8]. According to education, exposure to biodiversity ecosystems rich in plants, wildlife, and landscapes can offer unique psychological and physiological benefits that are more difficult to achieve in larger cities or monocultural areas [9]. Ecotourism research in diverse ecosystems can not only give visitors better physical activities and stress reduction but may also foster a conservation mindset, encouraging both private and societal dedication to protecting those environments [10].

Indeed, by promoting spectacular experiences with nature, ecotourism has the potential to raise awareness and appreciation of biodiversity, creating a deeper understanding of the connection between human and environmental health [11]. Despite the established benefits of nature-based tourism, research on the dual effect of biodiversity conservation and tourists' fitness remains limited [12]. They generally focused on either the ecological benefits of ecotourism or its impact on local economies, frequently forgetting how the biodiversity component of these stories might simultaneously contribute to visitors' health and well-being.

The aim of the study is to examine the impact of ecotourism on tourists' A healthy mental and physical state, taking into account the importance of biodiversity protection as shown in **Figure 1**.

The key contribution of this paper

- This research investigates Ecotourism's effects on visitors' physical and emotional well-being, with a focus on biodiversity protection.
- This study used to collect data from 685 tourists, which included age, gender, frequency of ecotourism participation, etc.
- This research uses social bonding, physical activity levels, mental well-being, stress reduction, and biodiversity awareness variables.
- This research highlights ecotourism's twin benefits for human health and environmental stewardship, emphasizing the importance of sustainable tourism practices.

Figure 1. The flow of ecotourism role in promoting health.

2. Related work

A categorization method for works initially produced during 2002 and 2021 was presented [13] and material analysis has been recognized as an observational technique for systematically analyzing resources, and the analysis of topics was used to address the study's questions. The findings demonstrated that, despite fluctuations over time, the overall publishing momentum in conservation was increasing. A great deal of ecological investigation was undertaken in poor countries, and the findings revealed that they continued to fail to manage their natural resources.

The population included tourism stakeholders such as travelers, LCR, CAO, hoteliers, and tour operators serving the area [14]. To assist respondents in understanding, 650 questionnaires were distributed, together with a summary of the important components. Data was examined using hierarchical regression after the instrument's reliability and validity had been established. According to the data, a considerable number of people perceive socioeconomic benefits, such as job and business opportunities, infrastructure improvements as a result of tourism, and growth. The correlation between environmental tourists' perceived reliability and perceived values, as well as how these elements influence revisit intentions and ecologically responsible behaviors, was the purpose of the investigation [15]. An examination research technique was employed, together with SEM, to examine the correlations between variables. The perceived reliability had a substantial impact on perceived values, which in turn undoubtedly motivated revisit intentions and environmentally responsible behaviors.

To assess the influence of ecotourism on the park's ecosystem, using dung

beetles as indicators. The three tourism intensity zones: conservation, extensive, and intensive were examined [16]. Pitfall traps were used to collect six samples in each zone between June and November 2013. Ecotourism in the park had negatively impacted the dung beetle assemblage structure, leading to the loss of habitat specialists and the emergence of widespread generalists.

The local communities' perceptions and the socio-economic effects of ecotourism development in Terengganu, Malaysia, specifically around Lake Kenyir and Sekayu Recreational Forests, were the purpose of the investigation [17]. A non-probability convenience sample method was used, and 310 respondents were given a structured questionnaire. Data was analyzed using factor analysis and the SEM. Positive consequences, such as job possibilities and homestay lodgings, were reported, as were negative impacts, such as resource degradation and disruption of religious traditions.

The relationship between ecotourism and BC in Ethiopia's Bale Mountains National Park was investigated [18]. The dynamic ecotourism components were analyzed and parameterized using a quantitative research strategy, while the relationship between ecotourism and conservation, as well as the significant hurdles it encounters, was evaluated using a qualitative approach. The findings provide light on the ongoing disputes and sustainable symbiosis between ecotourism and conservation, highlighting the need for immediate policy intervention, particularly to merge ecotourism ideas and practices with neoliberal conservation approaches.

The finest practices in the environmentally friendly handling of notable ecologies across the world have been identified [19]. Sixty-five top global ecotourism destinations have been identified and examined using (1) self-sufficient third-party ecology identifiers and (2) a tourism conceptual framework based on a strict definition of ecological tourism that highlights a nature-based focus, learning, sustainability (conservation and neighborhood involvement/benefits), and ethical parameters. To highlight the best practices in sustainable ecology management, focusing on conservation, community benefits, education, and social responsibility across key ecotourism characteristics.

To determine the state of the art, a combined documentary bibliographic approach was employed [20], with an assessment of numerous scientific publications, documents, books, texts, and doctorate theses. It exposed Ecuadorian individuals' lack of knowledge about the health benefits of ecological tourism and proposed solutions to address cultural ignorance and early education for a healthier population and a higher quality of life.

The impact of community-organized ecotourism on generating support for WLC among the residents in and near JCTRI was investigated [21] using the principles of social exchange and the theory of stakeholders. The findings showed that estimated involvement by communities in ecotourism decision-making had little influence on ecotourism support or conservation, but it did have a significant beneficial impact on perceived ecotourism advantages and CA.

The role of ER, innovation, and SN sites as direct predictors for healthy ecotourism growth and development, as well as the reducing impact of environmental philanthropy, were explored [22]. To investigate the model, they used a partial least squares path modeling technique. The study's findings indicate that

ecotourism regulation, innovation, and social media all have a substantial impact on ecotourism development, with environmental generosity playing a moderating role.

The long-term viability and responsiveness of factors impacting community-based AE in WJ were investigated [23]. The project involved an analysis of 237 AE participants from five tourist destinations. The five tourism settlements were purposefully chosen to WJ critical crossroads. They discovered that existing AE in WJ was commercially viable.

The community's understanding and attitudes towards ecotourism development in the forests of Arbegona and Nenseboworedas in southern Ethiopia were explained [24]. Interviews with household members and key informants were used to collect data, as were focus group discussions. The data showed that a majority (57.9%) of the participants had an unfavorable impression of forest-based tourism development.

The factors that influence Eco tourists' environmental behavior while visiting woods were analyzed [25]. They evaluated data from 409 recreational forest excursions using social cognition theory as a basis for analysis. After determining the data's quality and reliability, SEM was applied. The model explained 59% of Eco tourists' intentions and 27% of their actual environmentally positive behavior during forest trips.

Risk variables were examined when selecting ecotourism sites within a certain sphere. A quantitative study with 377 tourists examined [26] the relationship between various constructs. The data was analyzed using SPSS-AMOS. The impact of risk factors on tourists' decisions was highlighted. Addressing the issue was crucial for the Bangladesh government, policymakers, and tourism management to attract more tourists to ecotourism destinations. **Figure 2** demonstrates the research model of how these innovations can boost the impact of ecotourism on tourists' health.

Hypothesis development

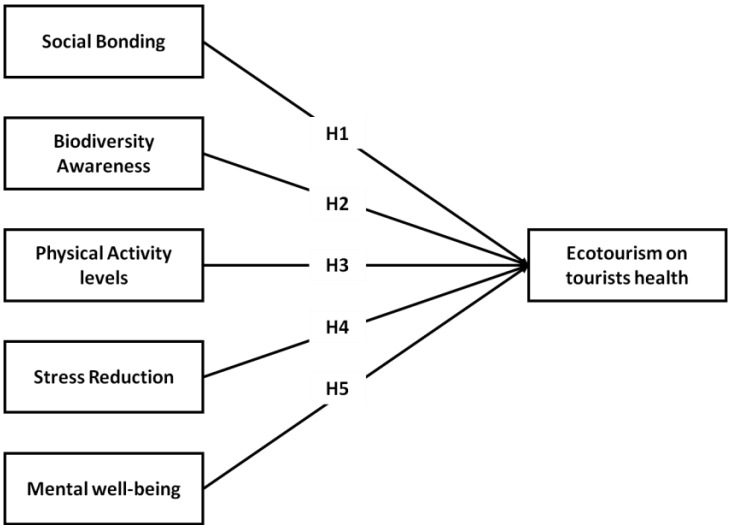

Figure 2. Research model.

Hypothesis 1: Social bonding positively impacts Ecotourism on tourists' health.

Social bonding has an impact on the health of ecotourism tourists'. Engaging in

group activities and forming connections with others promotes mental health by reducing stress and isolation. Social support promotes resilience, whereas physical activity in natural settings improves health. Furthermore, contact with local communities might promote positive moods and contribute to overall health benefits through ecotourism experiences.

Hypothesis 2: Biodiversity awareness positively impacts Ecotourism on tourists' health

Biodiversity awareness refers to tourists' understanding and attitudes towards biodiversity and its significance to ecosystems. These variable measures how aware and concerned visitors are about biodiversity protection, and it is intended to influence their behavior and thinking during and after their ecotourism experience. Increased awareness can lead to more effective campaigning for environmental preservation.

Hypothesis 3: Physical activity levels positively impact Ecotourism on tourists' health

Physical activity level measures the intensity and duration of tourists' physical engagement during an ecotourism visit, such as hiking, walking, or swimming. Physical activity level is an important part of ecotourism experiences because it has been shown to improve cardiovascular health, muscle strength, and general physical fitness, potentially benefiting tourists' physical well-being.

Hypothesis 4: Stress Reduction positively impacts Ecotourism on tourists' health

Stress reduction quantifies the amount to which ecotourism activities reduce tourists' stress levels. Engaging with nature and unplugging from regular routines can help the individual relax, reduce anxiety, and increase mental clarity. These variable measures the mental health advantages of ecotourism by emphasizing stress reduction.

Hypothesis 5: Mental Wellbeing positively impacts Ecotourism on tourists' health

Mental well-being relates to tourists' emotional and psychological state after their ecotourism experience, which includes things like mood improvement, emotions of joy, and overall mental rejuvenation. Spending time in natural, biodiversity-rich surroundings has been linked to improved mental health, increased mood, and a sense of calm and satisfaction.

3. Methodology

The purpose of this study is to investigate how ecotourism impacts tourists' health, with a particular emphasis on biodiversity conservation. In this context, the independent variables are physical activity levels, stress reduction, mental well-being, social bonding, and biodiversity awareness, while the dependent variable is ecotourism tourists' health. Data were collected from 685 tourists who visited biodiversity-rich sites and metrics on physical activity level, mental well-being, stress reduction, biodiversity awareness, and social bonding. The questionnaires provided real-time responses to ensure data accuracy. Statistical techniques, including descriptive statistics, Pearson's correlation, *T*-tests, multiple regressions,

descriptive statistical analysis, and ANOVA test, investigated the impact of ecotourism on tourists' health. **Figure 3** shows the overall flow of the framework. By providing protected places with income that can be used to fund conservation initiatives, ecotourism encourages the preservation of biodiversity. It increases public understanding of the value of diversification and the necessity of protecting habitat. By promoting ecological the utilization of land practices, biodiversity lessens the negative environmental effects of conventional tourist. Additionally, it offers financial incentives to nearby communities to protect natural resources rather than use them for profit. Additionally, by involving visitors in conservation initiatives like animal observation or education about the environment campaigns, ecotourism promotes support for biodiversity.

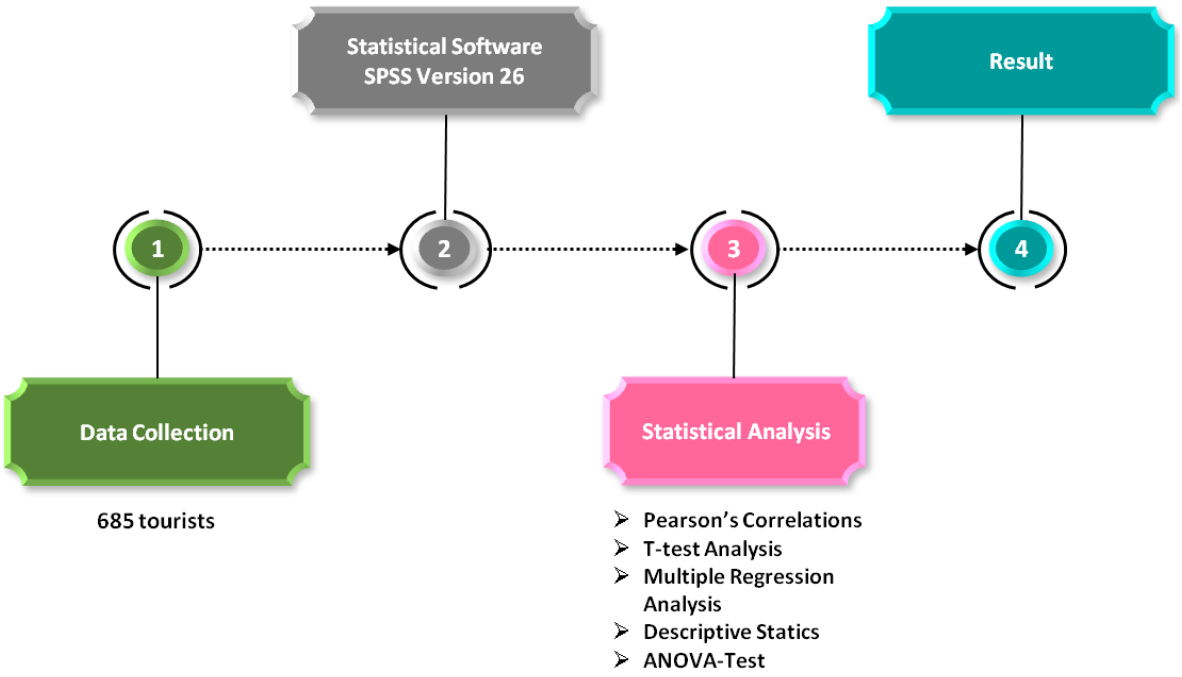

Figure 3. Overall flow of the designed model.

3.1. Data collection

A questionnaire-based approach was used to gather data for this study from 685 visitors to ecotourism destinations rich in biodiversity. The objective was to evaluate the effects of ecotourism on a range of health and well-being consequences, such as biodiversity comprehension, social bonding, physical activity levels, mental health, and stress reduction. To guarantee prompt and genuine answers that captured the immediate impacts of the tourists' ecotourism situations, the questionnaires were given out on-site while they were there. Information into how ecotourism excursions affect both individual health and ecological consciousness were provided by the structured questions, which concentrated on self-reported health indicators and attitudes toward biodiversity conservation. This method enabled for the real-time assessment of physical advantages and their relationship to exposure to a variety of habitats while guaranteeing that the data truly reflected the experiences of travelers. **Table 1** shows the demographic data. A demographic survey was also used to collect information on the participants' age, gender, Frequency of Ecotourism Participation

(FEP), Main Motivation for Visit (MMV), Type of Ecotourism Activity (TEA), Duration of Stay at Ecotourism Site (DSES), Previous Exposure to Biodiversity Conservation Programs (PEBCP), Health Status before Visit (HSPV), and Level of Interest in Biodiversity Conservation (LIBC).

Table 1. Demographic data of ecotourism experiences.

Demographic variables	Category	Frequency	Percentage (%)
Gender	Male	340	49.6%
	Female	345	50.4%
Age Group	18–25 years	150	21.9%
	26–35 years	210	30.7%
	36–45 years	170	24.8%
	46–60 years	110	16.1%
	60+ years	45	6.6%
FEP	First-time visitor	280	40.9%
	Occasional visitor	250	36.5%
	Frequent visitor	155	22.6%
MMV	Health and wellness	265	38.7%
	Nature exploration	210	30.7%
	Conservation awareness	120	17.5%
	Adventure and recreation	90	13.1%
TEA	Hiking	250	36.5%
	Wildlife observation	180	26.3%
	Nature walks	145	21.2%
	Camping	60	8.8%
	Others	50	7.3%
DSES	Less than 1 day	120	17.5%
	1–3 days	210	30.7%
	4–7 days	250	36.5%
	More than 7 days	105	15.3%
PEBCP	Yes	330	48.2%
	No	355	51.8%
HSPV	Excellent	140	20.4%
	Good	230	33.6%
	Fair	215	31.4%
	Poor	100	14.6%
LIBC	Very interested	220	32.1%
	Somewhat interested	210	30.7%
	Neutral	160	23.4%
	Not interested	95	13.9%

This demographic data table contributes to a better understanding of the various factors that may influence the relationship between ecotourism and tourist health

outcomes. By categorizing variables such as age, gender, frequency of ecotourism engagement, and reason for visiting, the study can better understand how these aspects affect tourists' physical and mental health, as well as their understanding of biodiversity conservation. These findings are essential in determining the advantages of ecotourism for personal well-being and environmental protection.

3.2. Structure of questionnaires

Social bonding: This section contains three questions designed to assess SB. This assumption investigates exploring how social bonding in ecotourism improves visitor health, emphasizing the interdependence of human well-being and biodiversity protection.

Biodiversity awareness: This section includes three questions to assess various aspects of SB, such as the adoption of novel processes. This section investigates if increased awareness of biodiversity during ecotourism activities has a positive impact on tourists' health.

Physical activity levels: The three questions in this section analyze various features of PA. This section describes how engaging in physical activities such as hiking or observing wildlife during ecotourism affects tourists' health.

Stress reduction: This section has three questions that can help the person comprehend SR. The impact of nature on stress reduction, specifically how ecotourism in natural environments reduces anxiety and promotes relaxation, was examined in this section.

Mental well-being: This section includes three questions intended to test MWB. The ecotourism's role in promoting mental well-being was accessed in this section. **Table 2** shows the sample questionnaires.

Table 2. Survey questions on ecotourism impact.

Variable	Number of questions	Survey questions
Social bonding	3	1) How often do you feel that ecotourism activities help you build connections with others? 2) How frequently do you find that ecotourism experiences strengthen your relationships with friends or family? 3) How often do ecotourism activities make it easier for you to connect with new people?
Biodiversity awareness	3	1) How frequently does your ecotourism experience increase your awareness of biodiversity? 2) How often do you feel more knowledgeable about conservation after an ecotourism activity? 3) How regularly do you feel that ecotourism experiences deepen your understanding of biodiversity?
Physical activity levels	3	1) How often do ecotourism activities involve more physical activity than your usual routine? 2) How frequently do you feel physically engaged during ecotourism experiences? 3) How often do you find the physical activities in ecotourism beneficial for your health?
Stress reduction	3	1) How often does your ecotourism experience lead to a noticeable reduction in stress? 2) How frequently do you feel more relaxed and rejuvenated after ecotourism activities? 3) How often does spending time in a natural environment help you manage stress better?
Mental wellbeing	3	1) How often do you feel that ecotourism improves your overall mental well-being? 2) How frequently does ecotourism leave you feeling emotionally refreshed? 3) How often do you find your mood positively impacted by an ecotourism experience?

3.3. Statistical evaluation

SPSS version 26 was used to conduct statistical analyses on the impact of ecotourism on tourists' health from the perspective of biodiversity conservation. Pearson's correlation is a statistical test used to investigate the connections between health outcomes and biodiversity awareness. *T*-tests were used to evaluate health indicators between groups of tourists who visited high or low-biodiversity locations, and multiple regression analysis was used to determine the predictive impact of biodiversity knowledge on overall health outcomes. To evaluate health outcomes and biodiversity awareness, descriptive statistics such as means, standard deviations, and minimum and maximum values, were used. ANOVA was used to assess the variance in health outcomes across different levels of biodiversity exposure, and there were significant differences. This statistical approach allows a full assessment of the impact of ecotourism on vacationers' physical and mental health in terms of biodiversity conservation.

4. Result

The results show that ecotourism has a positive impact on tourists' health and biodiversity awareness. Using the components in this section, the descriptive analysis, Pearson's correlation analysis, *t*-test analysis, multiple regression analysis, and ANOVA test analysis were evaluated.

4.1. Pearson's correlation analysis

The associations between important health outcomes physical level of activity, psychological well-being, decreased stress, biodiversity understanding, and social bonding in ecotourism destinations were evaluated using the Pearson's correlated coefficient. The degree and direction of the linear association between two constant variables are measured by this statistical technique. While a negative correlation implies the reverse, a positive correlation shows that when one variable rises, the other also tends to rise. The findings of the Pearson's correlation analysis, which are shown in **Table 3**, shed light on the connections between these medical conditions and emphasize the value of ecotourism in promoting personal wellbeing and environmental consciousness. The correlation coefficient (*r*)should be statistically significant, usually with a*p*-value less than 0.05. The explanation of the important findings is shown in **Figure 4**.

Table 3. correlation coefficient and *p*-value for predictor's ecotourism impact.

Predictors variables	**Correlation coefficient (*r*)**	***p*-value**
Social bonding	0.30	0.010
Biodiversity awareness	0.40	0.003
Physical activity levels	0.42	0.001
Stress reduction	0.36	0.005
Mental Well-being	0.49	0.001

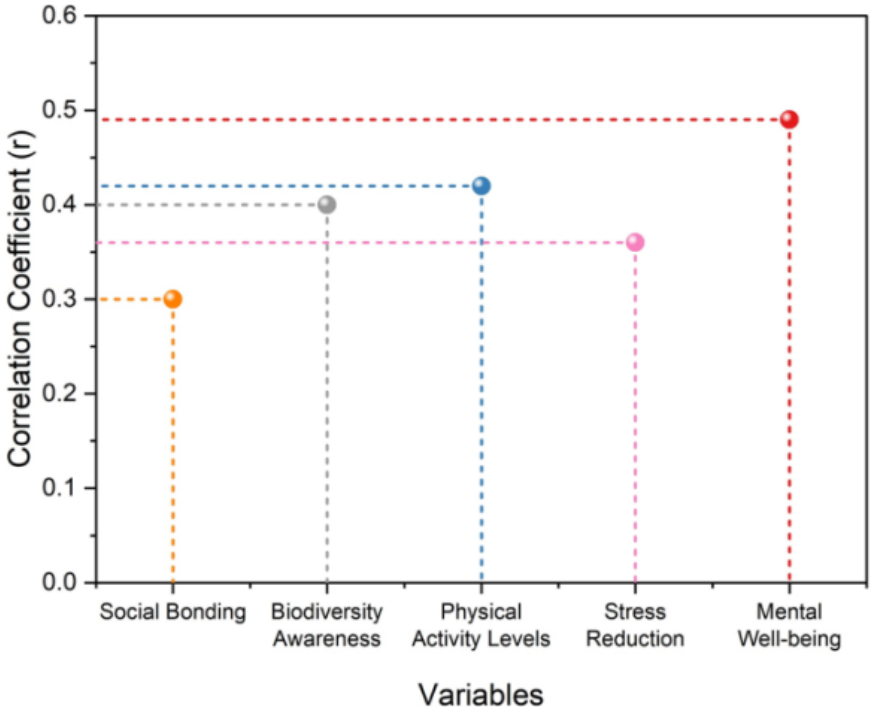

Figure 4. Pearson's correlation analysis result.

Social bonding:

In social bonding ($r = 0.30, p = 0.010$), a somewhat beneficial relationship is present social bonding and health outcomes. This validates Hypothesis 1, demonstrating that stronger social bonding in ecotourism settings benefits tourists' health.

Physical activity levels:

Physical activity level ($r = 0.42,\ p = 0.001$) shows a substantial positive connection, suggesting that physical activity levels are significantly associated with health outcomes. This supports Hypothesis 3, which emphasizes the health advantages of increased physical activity levels in ecotourism settings.

Mental well-being:

Mental well-being ($r = 0.49;\ p < 0.001$) shows a very substantial association, indicating that ecotourism activities have a significant impact on mental well-being, which supports Hypothesis 5. Ecotourism not only benefits mental health but also promotes total well-being.

Stress reduction:

In stress reduction ($r = 0.36, p = 0.005$), a somewhat substantial positive association is present stress reduction and health outcomes, supporting Hypothesis 4. Increased exposure to biodiversity-rich areas appears to considerably reduce stress, encouraging improved mental and physical health.

Biodiversity Awareness:

In biodiversity awareness ($r = 0.40;\ p = 0.003$), there is a considerable positive link between biodiversity knowledge and health outcomes, which supports Hypothesis 2. Tourists who are more aware of biodiversity report improved health, implying that knowledge of conservation improves well-being.

Pearson's correlation analysis results demonstrate a beneficial association

between biodiversity exposure and both physical and mental health outcomes for tourists. Ecotourism activities in high-biodiversity locations not only benefit tourists' health but also raise biodiversity awareness, fostering a cycle of health and environmental care. This illustrates ecotourism's dual benefits of improving human well-being while also raising ecological awareness.

4.2. *T*-test analysis

Travelers who visited rich in biodiversity areas and those who visited low biodiversity areas showed significant variations in key health indicators, including physical activity levels, psychological wellness, decreasing stress, ecological diversity knowledge, and social bonding, according to the *T*-test results shown in the table. According to these results, ecotourism encounters in regions with higher biodiversity have a significantly higher beneficial effect on a range of health conditions. Compared to their equivalents in low environmental areas, visitors to high biodiversity regions reported greater levels of sport participation, better mental health, and better decrease in stress, increased biodiversity awareness, and more durable social bonds. **Figure 4** provides a graphic representation of the specific outcomes of these assessments. The *t*-value is a measure of how different the pattern approach is from the variant within each group. $P - value = 0.000$, indicating that the observed difference is highly statistically significant. These findings are critical for understanding how biodiversity exposure affects tourists' health and environmental awareness. **Table 4** and **Figure 5** show the result of the *T*-test analysis.

Table 4. Comparison of predictors between high and low biodiversity areas.

Predictors	Biodiversity areas (high)	Biodiversity areas (low)	*t*-value	*p*-value
Social bonding	8.30 ± 1.12	5.85 ± 1.58	9.56	0.000
Biodiversity awareness	8.22 ± 1.07	6.75 ± 1.32	8.13	0.000
Physical activity levels	7.32 ±1.45	5.65 ± 1.87	7.14	0.000
Stress reduction	7.89 ± 1.19	6.34 ± 1.44	7.04	0.000
Mental well-being	8.15 ± 1.23	6.72 ± 1.56	6.59	0.000

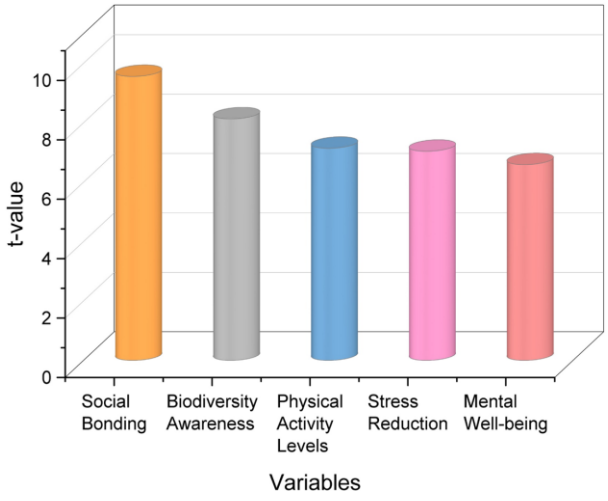

Figure 5. *T*-test outcome visualizations.

Tourists in high biodiversity areas reported improved social bonding ($mean = 8.30$) compared to low biodiversity areas ($mean = 5.85$), with significant impacts ($t = 9.56, p = 0.000$) ;this supports Hypothesis 1, demonstrating that biodiversity-rich environments encourage social connection, which has a positive impact on tourists 'health.

Tourists in high biodiversity areas demonstrated significantly higher biodiversity awareness ($mean = 8.22$) compared to low biodiversity areas ($mean = 6.75$), supporting Hypothesis 2. Exposure to different environments improves health outcomes and raises knowledge of biodiversity conservation.

Tourists in biodiversity-rich areas reported significantly higher physical activity levels ($mean = 7.32$) compared to low biodiversity areas($mean = 5.65$), with a *t*-value of 7.14 and *p*-value of 0.000and this supports Hypothesis 3, which connects biodiversity publicity to increased physical activity levels.

Stress reduction was significantly greater in high biodiversity areas ($mean = 7.89$) than in low biodiversity areas ($mean = 6.34$), supporting Hypothesis 4, which links biodiversity exposure to decreased stress and improved health.

Tourists in high biodiversity areas reported higher levels of mental well-being ($mean = 8.15, SD = 1.23$) than those in low biodiversity areas ($mean = 6.72, SD = 1.56$), with a *t*-value of 6.59 and a *p*-value of 0.000, indicating a statistically significant difference. This provides importance to Hypothesis 5, which holds that increased biodiversity exposure promotes mental health.

All predictors have strong positive relationships with health outcomes, supporting the hypothesis that social connection, biodiversity awareness, physical activity levels, stress reduction, and mental well-being contribute to ecotourism's health benefits. These findings give compelling evidence that ecotourism in biodiversity areas provides significant health advantages to tourists while also raising environmental awareness. The graph 5 shows the relationship between biodiversity regions and several health outcomes, including social connection, decreasing stress, emotional wellness, physical exercise, and biodiversity understanding. It demonstrates that all results are positively correlated, with greater health advantages found in places with higher biodiversity. This supports the notion that more diverse environments benefit visitors' general well-being.

4.3. Multiple regression analysis (MRA)

MRA investigates the predictive impact of biodiversity awareness on average health outcomes while controlling for other variables. This assessment assessed the extent to which biodiversity recognition predicts high-quality health outcomes, emphasizing the importance of ecotourism in promoting health benefits through conservation education. It addresses a variety of factors, distinguishing the distinctive impact of ecotourism on tourist health, and promotes ecotourism's capacity to work as both a health-promoting and conservation-enhancing social activity. A *p*-value less than 0.05is commonly used to indicate statistical significance. The p-value determines if the coefficient is significantly different than zero. **Table 5** illustrates the results of multiple regression analysis that investigate how various variables influence tourist's health outcomes. The primary variable in

this study is tourist's health outcomes, which can be measured using a variety of indicators such as physical activity levels, mental well-being, stress reduction, social bonding, and biodiversity awareness (**Figure 6**).

Table 5. Hypothesis testing results with multiple regressions.

Hypothesis	Coefficient (β)	Standard error	*t*-statistic	*p*-value
H1	0.42	0.06	7.00	0.000
H2	0.35	0.05	7.00	0.000
H3	0.30	0.08	3.75	0.000
H4	0.28	0.07	4.00	0.000
H5	0.37	0.07	5.29	0.000

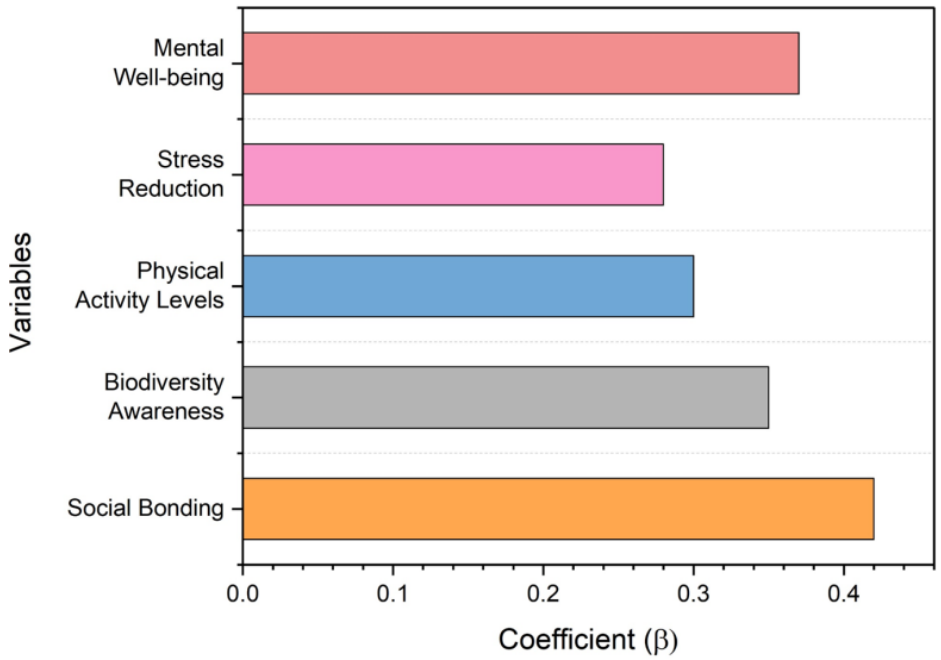

Figure 6. Statistical multiple regression findings.

Social bonding in ecotourism significantly improves health outcomes. Hypothesis 1 is supported by a $\beta = 0.42$ and a *t*-value of 7.00 ($p = 0.000$), demonstrating that stronger social connections have a beneficial impact on traveler fitness.

Higher biodiversity awareness enhances tourists' health, as demonstrated byβ=0.35 and a *t*-value of 7.00 ($p = 0.000$). This supports Hypothesis 2, suggesting that greater knowledge leads to better health outcomes.

Improved physical activity levels are associated with advanced health outcomes. The $\beta = 0.30$ and *t*-value of 3.75 ($p = 0.000$) support Hypothesis 3, demonstrating that ecotourism promotes physical activity levels and improves outcomes.

Ecotourism decreases stress reduction and improves health, with β= 0.28 and a *t*-value of 4.00 ($p = 0.000$). This confirms Hypothesis 4, which states that biodiversity exposure reduces stress and improves health.

Ecotourism significantly improves mental well-being ($\beta = 0.37$, *t*-value = 5.29,

p = 0.000); this supports Hypothesis 5, which emphasizes the strong influence of ecotourism on mental health.

The multiple regression analysis shows that biodiversity awareness and biodiversity level are the best predictors of health outcomes among tourists. The findings indicate that exposure to rich biodiversity and improved knowledge of its value has the greatest influence on both physical and mental health. The findings highlight ecotourism's multiple benefits, which promote both tourist health and biodiversity conservation, reinforcing the need for sustainable tourism practices. Significantly positive associations are highlighted in the graph, which displays the associations between various biodiversity areas and health results. Areas with higher biodiversity typically have stronger relationships with social connection, alleviating stress, mental health, and physical activity. This implies that increased biodiversity improves these health outcomes for tourists who come for ecotourism.

4.4. Descriptive statistics analysis

Descriptive statistics give an overview of the data by summarizing the essential characteristics of each variable, such as social bonding, biodiversity awareness, physical activity levels, stress reduction, and mental well-being. This comprises the mean (average score), standard deviation (variance in replies), and minimum and maximum values, which provide information about the distribution of responses among tourists. **Figure 7** depicts the effects of the descriptive statistics efficiency. The mean frequently scored higher than 4, indicating that tourists had primarily positive outcomes in terms of social connection, biodiversity awareness, physical interest, stress reduction, and mental well-being. The standard deviations indicate that, while most tourists gave similar experiences, there was yet significant variation in individual comments. The smallest and highest values reflect the diversity of reports, ranging from those with minimal involvement or health advantages to those who experienced highly positive outcomes. These data provide a basic initial summary that allows for a more detailed analysis of how these innovations impact ecotourism on tourists' health, as seen in **Table 6**.

Table 6. Descriptive statistics of variables related to ecotourism impact.

Variable	*N*	Mean	Standard deviation (SD)	Minimum (min)	Maximum (max)
Social bonding	685	4.12	0.85	1.00	5.00
Biodiversity Awareness	685	3.87	0.90	1.00	5.00
Physical Activity Levels	685	4.25	0.75	1.00	5.00
Stress Reduction	685	4.15	0.82	1.00	5.00
Mental Well-being	685	4.30	0.77	1.00	5.00

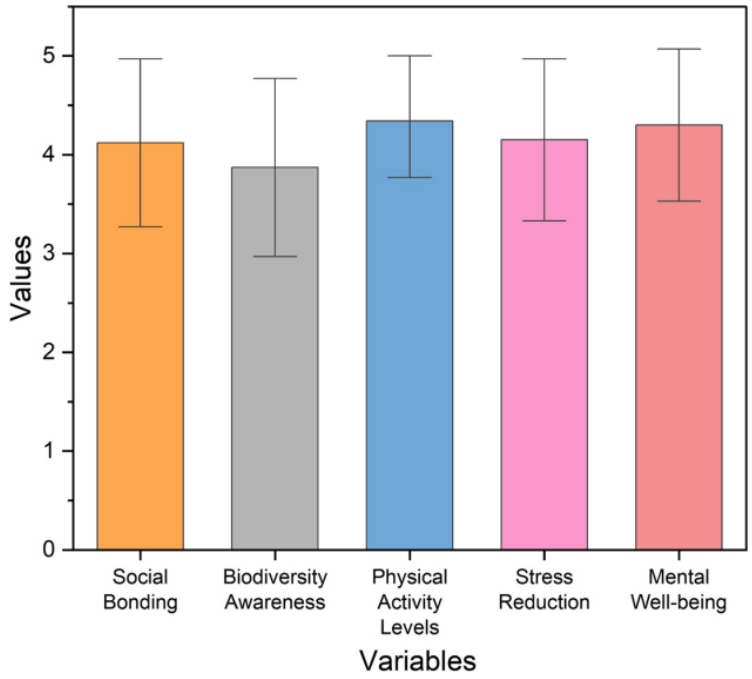

Figure 7. Performance of descriptive statistics.

The social bonding (mean = 4.12, SD = 0.85) shows the variety of ecosystems seen by tourists. Higher levels of biodiversity are frequently associated with improved physical and mental health, an outcome that supports Hypothesis 1.

Biodiversity awareness (mean = 3.87, SD = 0.90) measures tourists' comprehension of ecological systems. Increased awareness may increase the health advantages of ecotourism, lending support to Hypothesis 2 on health improvement.

Physical activity levels (mean = 4.25, SD = 0.75) demonstrate how engaging ecotourism activities encourage exercise. Hence supporting Hypothesis 3, active participation in nature-based tourism has been found to promote health.

Stress reduction (mean = 4.15, SD = 0.82) assesses how ecotourism reduces stress. Nature exposure is proven to alleviate stress, providing strong support for Hypothesis 4, which enhances the health advantages of ecotourism.

The psychological health of tourists is assessed using mental well-being (mean = 4.30, SD = 0.77). Nature-based tourist activities promote mental health, which strongly supports Hypothesis 5 that ecotourism improves general health and well-being. The graph shows the average scores of visitors to high and low biodiversity areas for a number of health indicators, including social bonding, alleviating stress, emotional well-being, sports participation, and environmental awareness. Visitors to regions with great biodiversity routinely score higher on every health metric. This implies that ecotourism participant' physical and mental well-being are more significantly improved by places with higher biodiversity.

4.5. ANOVA test analysis

To ascertain whether the means of more than three distinct groups differ significantly from one another, a statistical method called an ANOVA is employed. It assesses the proportion of the data's overall variability that can be ascribed to group differences as opposed to variability within each group. To determine whether

the collection of means differ considerably from one another, the *F*-statistic is computed by dividing the difference between groups by the within-group variability. A higher F-value suggests that there is a larger chance that the variations between groups represent genuine variation, which is frequently influenced by elements like effects of therapy or innovation, rather than being the result of unpredictability. The *p*-value is less than 0.05; the observed changes are statistically significant and are most likely the result of random fluctuation. The *P*-value is the probability that the results were produced using full potential. **Table 7** presents the results of an ANOVA test.

Table 7. Hypothesis testing results with ANOVA results by variable.

Hypothesis	**Mean FP**	***F*-statistic**	***p*-value**
H1	73	4.12	0.027
H2	79	5.48	0.014
H3	72	3.96	0.032
H4	85	6.23	0.005
H5	76	5.61	0.018

H1: The average ecotourism on tourists' health for $H1\ is\ 73$, indicating a significant positive impact on tourist health (*p*-value = 0.027, *F*-statistic = 4.12).

H2: The average ecotourism on tourists' health for H2 is 79, indicating a substantial positive impact on tourist well-being (*p*-value = 0.014, *F*-statistic = 5.48).

H3: The mean ecotourism on tourists' health for $H3\ is\ 72$, indicating a statistically significant but moderate influence on mental and physical health (p = 0.032, *F*-statistic = 3.96).

H4: The average ecotourism on tourists' health for $H4\ is\ 85$, indicating a substantial increase in health outcomes (*p*-value = 0.005, *F*-statistic = 6.23).

H5: The mean ecotourism on tourists' health for $H5\ is\ 76,$ indicating a substantial impact on tourists' overall health (*p*-value = 0.018, *F*-statistic = 5.61).

The mean ecotourism on tourists' health, *p*-value, and *F*-statistic for the corresponding hypothesis reveal that all hypotheses produce significant results (with *p*-values less than 0.05), demonstrating an advantageous impact on tourist health outcomes.

5. Conclusion

This study demonstrated how ecotourism benefits tourists' physical and mental well-being, as well as its function in raising awareness about biodiversity conservation. Using data obtained from 685 tourists in several biodiversity-rich areas, it was discovered that exposure to diverse ecosystems improves both physical and mental health outcomes. Descriptive analysis was used to reveal high mean scores for all important variables, with physical activity levels and mental well-being having particularly higher averages (4.25 and 4.30, respectively), health measures, and biodiversity awareness. Pearson's correlation test found the most significant relationships between mental well-being ($r = 0.49$) and physical activity levels($r = 0.42$).$The\ t-tests$ revealed that the tourists visiting high biodiversity regions

reported considerably increased social bonding ($M = 8.30$) and biodiversity awareness ($M = 8.22$), which improved health outcomes.By concentrating on how ecotourism, especially in regions with significant biodiversity, affects visitors' health outcomes including stress reduction, behavioral wellness, and physical activity, the study adds to our comprehension. It adds a new perspective to the larger field of ecotourism research by offering empirical proof of the benefits of preservation of biodiversity on healthcare. The education about biodiversity in encouraging both environmental and human well-being. Furthermore, regression analysis revealed that ecotourism's health benefits were most significantly predicted by social bonding ($\beta = 0.42$), and mental well-being ($\beta = 0.37$), which is a strong predictor of overall health outcomes, emphasizing its importance in affecting tourists' physical and mental well-being. The ANOVA results show substantial differences across groups, with p-values ranging from 0.005 to 0.032, showing that ecotourism improves tourists' health, specifically through biodiversity conservation. Limitations of this study include its dependence on self-reported data, which may introduce biases, and its emphasis on short-term health outcomes without considering long-term effects. Furthermore, the study is limited to specific biodiversity-rich places, which may not accurately reflect ecotourism's worldwide impact. Future research should explore longitudinal health effects, expand to diverse ecotourism destinations, and determine the role of socioeconomic factors in health outcomes related to ecotourism.

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Abbreviation

Full form	Abbreviations
Structural Equation Model	SEM
Tayrona National Natural Park	TNNP
National Park's biodiversity	NPB
International Ecotourism Society	TIES
West Java's	WJ
Agro-ecotourism	AE
ecotourism regulations	ER
social networking	SN
local community representatives	LCR
civil administration Officers	CAO
biodiversity conservation	BC
Jim Corbett Tiger Reserve India	JCTRI
conservation awareness	CA
wildlife conservation	WC

socio economic	SE
ecotourism development	ED

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