

Assessing The Impact Of Artificial Intelligence-Enhanced Feedback Systems On College Students 'English Writing Skills'

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The automatic feedback systems which use artificial intelligence (AI) technology now produce instant feedback to academic writers which correct their grammar errors and vocabulary usage and writing coherence problems. The research used a quantitative cross sectional study design which involved 200 undergraduate students at Tsinghua University who completed a structured 30 item questionnaire to provide information about their personal backgrounds and their digital platform usage and their perceived improvements and their difficulties and their overall satisfaction. The research team utilized Partial Least Squares Structural Equation Modeling to analyze data while maintaining methodological standards through the evaluation of reliability and validity and structural relationships. This research employs of quantitative cross-sectional analysis through structured questionnaire and PLS-SEM. Key statistics such as path coefficient ($\beta = 0.851, 0.392$), effect size ($f^2 = 2.627, 0.234$) and capacity ($R^2 = 0.819$).

Keywords: Artificial Intelligence; Feedback Systems; English Writing Skills; PLS-SEM; Academic Satisfaction; Challenges and Concerns

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1. Introduction

Artificial intelligence has become central force in reshaping higher education, particularly in domain of academic writing [1]. College students increasingly rely on AI-enhanced feedback systems such as Grammarly, ChatGPT, and QuillBot to improve their English writing skills through better grammar, vocabulary, coherence, and organizational abilities [2]. Writing proficiency serves as an academic assessment tool which additionally provides people with essential skills for professional success and ongoing communication throughout their lives [3].

AI feedback systems developed through natural language processing and machine learning advancements which allow automated systems to evaluate text and deliver specific user corrections [4]. Similarly, Lund [5] demonstrates that educational methods create learning benefits

while their students face copyright violations and difficulties in critical analysis.

The AI-powered writing software is based on the principles of Natural Language Processing (NLP). This facilitates the analysis and provision of feedback automatically. Self-regulated learning (SRL) theory provides an explanation of how learners leverage such feedback to enhance their writing abilities. The ability of AI-supported feedback to contribute to the development of English writing skills is based on the idea of a sequential path to learning, during which the mistakes made by students are corrected through automation, and the writing piece is revised.

RQ1: How do demographic factors (age, gender, year of study, and English proficiency) influence the use of AI-enhanced feedback systems among college students?

RQ2: What patterns of usage (frequency, purpose, duration, and type of assignments) characterize college students'

engagement with AI feedback tools?

RQ3: To what extent do AI-enhanced feedback systems improve college students' English writing skills in terms of grammar, vocabulary, coherence, confidence, and writing frequency?

RQ4: What challenges and concerns (accuracy, critical thinking, plagiarism, over-reliance, and conflict with teacher feedback) do college students report when using AI feedback systems?

RQ5: How satisfied are college students with AI-enhanced feedback systems, and what are their attitudes toward future integration of these tools into academic writing instruction?

H1: There is a significant difference in the use of AI feedback systems across demographic groups such as age, gender, year of study, and English proficiency.

H2: Students who use AI feedback systems more frequently report higher levels of engagement in academic writing tasks.

H3: AI-enhanced feedback systems significantly improve students' English writing skills in grammar, vocabulary, and coherence compared to traditional feedback.

H4: Students who rely heavily on AI feedback systems report higher concerns about plagiarism, reduced critical thinking, and over-reliance compared to moderate users.

H5: Students with positive experiences using AI feedback systems express stronger intentions to continue using them and support their integration into classroom teaching.

- Analyze the influence of demographic factors (age, gender, year of study, and proficiency) on AI Usage by applying ANOVA/Chi-square (SPSS).
- Evaluate the relationship between frequency of AI tool usage and engagement in academic writing tasks using Correlation (SPSS).
- Measure the impact of AI-enhanced feedback systems on grammar, vocabulary, and coherence improvements through PLS-SEM structural modeling.

The paper is divided into four parts. Part, one gives the background of the research, stating the problem, gaps, questions, objectives, and hypotheses. Part two discusses the review of the literature for purposes of building the conceptual framework. Part three discusses the methodology used in collecting the data such as design, methods, variables, and analysis through the Partial Least Squares Structural Equation Modeling approach.

2. Materials and methods

Krajka and Olszak [6] found that applied linguistics students used their language knowledge and writing skills to identify the difference between human-written and AI-generated texts while they used AI tools to create summaries and generate text. The study by Jaramillo et al. [7] found that bilingual secondary students in Colombia showed improved writing skills when their writing workshop used both Grammarly and ChatGPT. The research demonstrates that AWCF has developed into a more adaptive system which provides contextualized feedback through its use of generative artificial intelligence. The evolution of this system improves the performance of AI writing assistance tools. The system supports AI-based language learning methods which use feedback to help students develop their writing skills and cognitive abilities through self-directed learning.

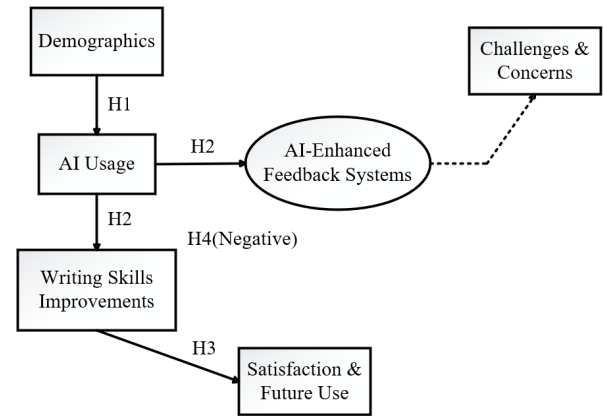


Fig. 1. Conceptual Research Model illustrating relationships among AI Usage

The research model shown in Fig. 1 demonstrates how researchers believe various constructs connect to each other because they affect college students' usage of AI-enhanced feedback systems. The dynamic interaction between AI-enhanced feedback and student writing performance through an iterative feedback loop, where real-time AI suggestions guide continuous revision and refinement. When students use feedback to correct grammar, vocabulary, and coherence, their writing can improve and further refine their interactions with AI tools, which are part of a cyclical process that enhances learning outcomes. The theoretical framework comprises the latent variables AI Usage (the independent variable), Writing Skills Improvement (the mediator), Satisfaction (the dependent variable), and Challenges (the moderator). The mediating effect of Writing Skills Development is used to explain the link be-

tween AI Usage and Satisfaction. Challenges are used as the moderating variable.

The relationship between AI Usage and Satisfaction is established through AI Usage because it enables feedback tool assessment, which learners need for their learning process. The study shows that challenges serve as a moderating factor which alters the strength of relationships and explains research model pathways. The study operational structure by demonstrating that issues like cognitive dependence and academic integrity issues interact with student perceptions, especially satisfaction, as a mediating factor in PLS-SEM model. The behavioral interaction of learners with AI-enhanced feedback systems in terms of the frequency and efficacy of interaction with feedback to revise and improve are important elements that determine the outcome of education performance. The systematic and intentional engagement with AI tools allows the students to internalize the feedback. The study surveyed 200 college students using a 30-item questionnaire which assessed their background and AI usage and writing impact and challenges and their overall evaluation of AI-based feedback systems. The thirty-item format was selected to avoid survey fatigue, maintain respondent convenience, and offer adequate coverage of all key constructs. The items were divided into five sections: obstacles, writing improvement, demographics, AI utilisation, and satisfaction. In order to allow evaluating the views of students correctly, every concept had a number of items. The questionnaire was developed based on the study objectives, with items constructed to represent each research variable across five sections: demographics, AI usage, writing improvement, challenges, and satisfaction. Every section consisted of several items that covered the experiences of students, which were measured by responses on Likert scale to provide consistency and to be appropriate to use in the analysis. Cronbach alpha and Composite Reliability (CR) were used to test internal consistency by measuring the reliability and stability of construct measurement, and the indicator loadings with Average Variance Extracted (AVE) to test convergent validity. Heterotraitmonotrait (HTMT) ratio was used as a measure of discriminant validity, which guaranteed the distinctiveness of the construct and helped to prove the overall soundness of the measurement model.

Researchers begin their research process which Fig. 2 shows by identifying problems which they need to study. The research design was a cross-sectional survey design, which provided data at one moment in time, which was studied efficiently because of the relations among AI usage, writing improvement, and satisfaction. Participants were recruited using a convenience sampling approach;

they had to be accessible and must have been exposed to AI tools before. A sample size of 200 undergraduate students of Tsinghua University was used, which is sufficient to analyze the PLS-SEM. This sample size is adequate to provide sufficient statistical power to test the proposed model. The study collects data from 200 participants who answer through Likert-scale questions. The online platform administered the survey, which distributed the questionnaire link through institutional channels to participants who submitted their responses during a specified time period, while mandatory response fields and structured question sequencing ensured complete and accurate participant submissions.

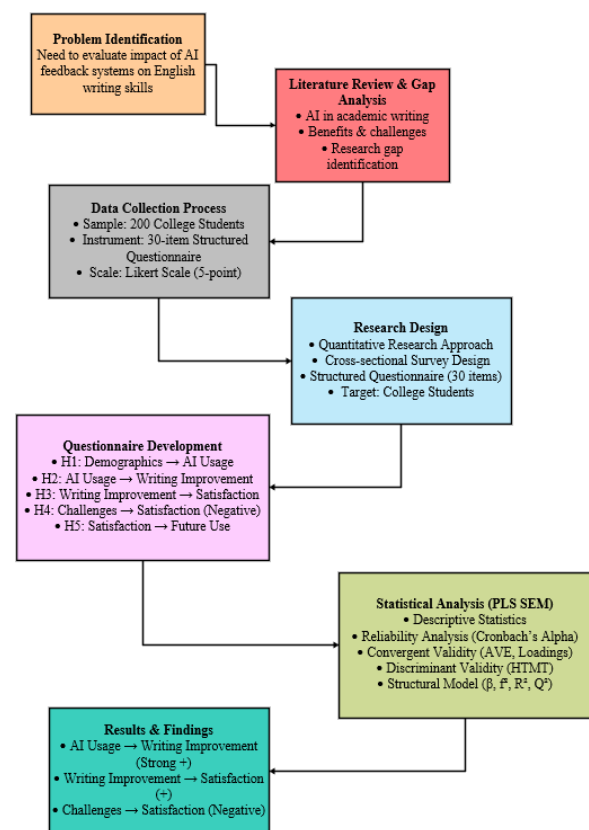


Fig. 2. Research Process Flowchart for Evaluating AI Feedback Systems

The research employs a cross-sectional survey study that uses a 30-item questionnaire developed from five testable hypotheses (H1 through H5) to collect Likert-scale data from 200 college students at Tsinghua University. The sample population was recruited through convenience sampling, via online survey and academic contacts. A screening question was used to verify previous AI tool use (e.g., Grammarly, ChatGPT, Quill Bot). The three months usage

Table 1. Descriptive Statistics of Study Variables

	Mean	Median	Observed min	Observed max	Number of observations used	Standard deviation
AI_Usage	0.00 0	0.025	-2.556	3.037	200.000	1.000
Challenges	0.00 0	0.296	-3.260	3.852	200.000	1.000
Satisfaction	0.00 0	0.258	-2.326	3.108	200.000	1.000
Writing Skills_Improvement	0.00 0	-0.010	-2.553	3.526	200.000	1.000

Table 2. Demographic Profile of Respondents

Variable	Category	Frequency	Percent	Valid Percent	Cumulative Percent
Gender	Category 1	31	15.5	15.5	15.5
	Category 2	95	47.5	47.5	63
	Category 3	49	24.5	24.5	87.5
	Category 4	25	12.5	12.5	100
Age Group	Group 1	87	43.5	43.5	43.5
	Group 2	94	47	47	90.5
	Group 3	19	9.5	9.5	100
Year of Study	Year 1	18	9	9	9
	Year 2	71	35.5	35.5	44.5
	Year 3	52	26	26	70.5
	Year 4	30	15	15	85.5
	Year 5	29	14.5	14.5	100
Stream	Category 1	27	13.5	13.5	13.5
	Category 2	103	51.5	51.5	65
	Category 3	70	35	35	100

criterion used was that of recent experience and reduced recall bias.

The research used survey indicators to measure independent variables, which included three demographic factors through categorical items for age and gender and academic level, while AI feedback usage patterns were measured through indicators that tracked usage frequency, usage purposes, interaction time and assignment types, which allowed researchers to measure their effect on writing improvement and satisfaction through systematic quantitative analysis.

PLS-SEM is based on a two-step process that comprises the evaluation of the measurement model in terms of reliability and validity, followed by the analysis of the structural model in terms of path coefficient, f^2 , and R^2 . The process followed a structured sequence to ensure methodological rigor and reproducibility:

The measures of descriptive statistics, such as mean, median, standard deviation, and range, were computed before conducting the SEM analysis. The research considered demographics and AI use, where the constructs were measured with several survey measures. The research study defines AI Usage through three specific indicators which show how students use AI tools throughout their activities.

The system allows students to practice their writing skills while receiving immediate feedback and participating actively in all writing exercises, which leads to higher student involvement. The researcher assessed outer loadings of indicators to confirm that every item produced significant value to its associated construct.

The PLS-SEM framework uses AVE to measure convergent validity through its assessment of the variance that each construct's indicators successfully explain. The calculation of AVE requires finding the average of all squared factor loadings that represent the indicators. The threshold of AVE which exceeds 0.50 demonstrates that a construct can account for more than 50 percent of its indicator variance. The HTMT ratio was used to evaluate discriminant validity through correlation analysis of constructs like AI usage, challenges, satisfaction, and improved writing skills. The HTMT ratios were all less than 0.90, indicating that the constructs have discriminant validity and are not plagued by multicollinearity problems.

This research examined the effect of demographic factors and utilization of feedback from the AI tool on writing performance and satisfaction. The future of the writing performance was tested using path coefficients, f^2 , and R^2 . This research employed the use of SmartPLS 4 software

Table 3. Correlation Matrix of Study Constructs

	AI_Usage	Challenges	Satisfaction	Writing Skills_Improvement
AI_Usage	1.000	0.071	0.802	0.851
Challenges	0.071	1.000	-0.266	0.081
Satisfaction	0.802	-0.266	1.000	0.816
Writing Skills_Improvement	0.851	0.081	0.816	1.000

Table 4. Outer Loadings of Measurement Model

Outer loadings	
Q10 <- AI_Usage	0.893
Q11 <- AI_Usage	0.917
Q12 <- AI_Usage	0.914
Q13 <- Writing Skills_Improvement	0.900
Q14 <- Writing Skills_Improvement	0.870
Q15 <- Writing Skills_Improvement	0.856
Q16 <- Writing Skills_Improvement	0.887
Q17 <- Writing Skills_Improvement	0.880
Q18 <- Writing Skills_Improvement	0.881
Q19 <- Challenges	0.875
Q20 <- Challenges	0.889
Q21 <- Challenges	0.903
Q22 <- Challenges	0.878
Q23 <- Challenges	0.884
Q24 <- Challenges	0.908
Q25 <- Satisfaction	0.909
Q26 <- Satisfaction	0.908
Q27 <- Satisfaction	0.894
Q28 <- Satisfaction	0.907
Q29 <- Satisfaction	0.905
Q30 <- Satisfaction	0.910
Q7 <- AI_Usage	0.924
Q8 <- AI_Usage	0.916
Q9 <- AI_Usage	0.914

based on a sample of 200 participants. The mediating effect of Writing Skills Improvement provides a valuable understanding of the relationship between AI Usage and Satisfaction by showing that AI tools positively affect satisfaction indirectly and directly by improving performance in writing. The structural model showed that AI Usage produced strong positive impacts on Writing Skills Improvement which had a standardized coefficient of 0.851 and an effect size of 2.627, and on Satisfaction which had a standardized coefficient of 0.392 and an effect size of 0.234, while Challenges produced a negative effect on Satisfaction which had a standardized coefficient of -0.335 and an effect size of 0.616. Path coefficients (β) indicate the strength and direction of relationships between constructs in the proposed model, where higher values represent stronger effects. In this study, AI Usage shows a strong positive impact on Writing Skills Improvement ($\beta = 0.851$) and a moderate effect on Satisfaction ($\beta = 0.392$), demonstrating its

role in enhancing performance and indirectly influencing satisfaction through skill development. The AI-generated feedback in this study improves the linguistic coherence by examining the sentence structure, logical flow, and semantic relationships and suggests how to connect words, restructure sentences, and further organize the ideas. With the help of feedback and revision, students work on idea development and transitions, which mains to their more articulate expression and coherent academic writing. The methodology is the basis on which the evaluation of the proposed model is founded, and the findings are discussed below.

3. Results and discussion

Descriptive statistics present participant demographic information and their AI usage patterns through mean value calculation and median value assessment and standard deviation measurement and range determination.

The descriptive statistics in Table 1 summarize the distribution of the main study variables used in the PLS-SEM analysis. The data shows all constructs which have mean and median values that approach zero. The range of values and standard deviation (1.000) confirm variability and normalization across 200 observations.

The Table 2 displays the demographic information of 200 respondents using four different criteria which include their gender and age group and year of study and academic stream. The majority of participants fall under Category 2 in gender (47.5%), Group 2 in age (47.0%), and Year 2 in study (35.5%).

Table 3 presents the correlation matrix showing relationships among AI Usage, Writing Skills Improvement, Satisfaction, and Challenges.

Table 4 shows that all AI Usage indicators and Writing Skills Improvement metrics and Challenge indicators and Satisfaction indicators reach outer loadings which exceed the 0.70 threshold thus demonstrating strong indicator reliability and convergent validity. The highest loading for AI Usage occurs at Q7 which has a value of 0.924 while Writing Skills Improvement shows a minimum loading of 0.856.

The results of Table 5 demonstrate that all constructs

Table 5. Construct Reliability and Validity

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
AI_Usage	0.960	0.961	0.968	0.834
Challenges	0.947	0.950	0.958	0.791
Satisfaction	0.956	0.956	0.965	0.820
WritingSkills_Improvement	0.941	0.941	0.953	0.772

show both reliable measurements and valid measurement properties. The Cronbach's alpha values which range between 0.941 and 0.960 confirm that the internal consistency of the test shows high assessment results. The AVE values which range between 0.772 and 0.834 exceed the required minimum value which enables the test to achieve proper convergent validity.

Table 6. Heterotrait-Monotrait Ratio (HTMT)

Heterotrait-monotrait ratio (HTMT)	
Challenges <-> AI_Usage	0.077
Satisfaction <-> AI_Usage	0.835
Satisfaction <-> Challenges	0.278
Writing Skills_Improvement <-> AI_Usage	0.895
Writing Skills_Improvement <-> Challenges	0.088
Writing Skills_Improvement <-> Satisfaction	0.860

Table 6 shows that all HTMT values are below the 0.90 threshold which establishes strong discriminant validity between all measured constructs. The lowest relationships are observed between Challenges and AI Usage (0.077) and Writing Skills Improvement and Challenges (0.088), which indicates clear construct separation.

As shown Table 7, AI application plays a significant role in determining writing skills improvement ($\beta = 0.851$, $f^2 = 2.627$), as well as having a moderately positive relationship to satisfaction ($\beta = 0.392$, $f^2 = 0.234$), whereas improvement in writing skills positively affects the satisfaction level ($\beta = 0.509$, $f^2 = 0.394$), but encountering difficulties reduces satisfaction ($\beta = -0.335$, $f^2 = 0.616$). From the above analysis, it is clear that the effect of AI Usage on Writing Skills Improvement is very significant ($\beta = 0.851$), as well as on Satisfaction, which is somewhat significant ($\beta = 0.392$). The effect sizes of 2.627 for writing skills and 0.234 for satisfaction further substantiate the results. These results corroborate those from previous studies conducted by Othman [3], Lund [5], and Jaramillo et al. [7]. They found that the use of artificial intelligence in providing feedback significantly enhances the quality of students' writing but might cause difficulties such as overdependence and plagiarism concerns.

Table 8 displays high explanatory ability for the pro-

Table 7. Path Coefficients and Effect Sizes of the Structural Model

Constructs	Path Coefficients (β)	f-square
AI_Usage $\rightarrow$ Satisfaction	0.392	0.234
AI_Usage $\rightarrow$ Writing Skills_Improvement	0.851	2.627
Challenges $\rightarrow$ Satisfaction	-0.335	0.616
Writing Skills_Improvement $\rightarrow$ Satisfaction	0.509	0.394

posed model. The variable "Satisfaction" exhibits an R^2 value of 0.819 (adj. 0.816), suggesting that almost 81% of its variance can be explained by AI Usage, Improvement in Writing Skills, and Challenges.

Table 8. R^2 Values of Endogenous Constructs

	R-square	R-square adjusted
Satisfaction	0.819	0.816
Writing Skills_Improvement	0.724	0.723

Table 9. Model Fit Indices (Saturated vs. Estimated Model)

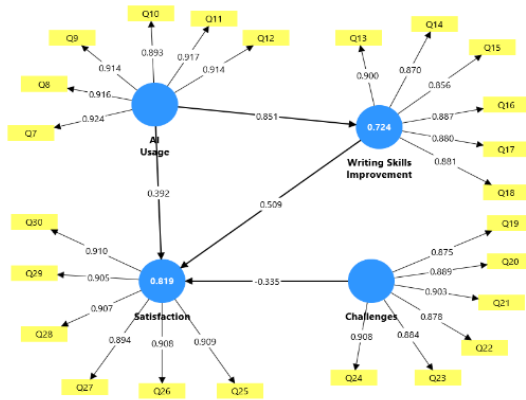
	Saturated model	Estimated model
SRMR	0.032	0.034
d_ULS	0.317	0.338
d_G	0.333	0.337
Chi-square	372.422	379.602
NFI	0.932	0.930

The structural model representing the association between AI Usage, Writing Skills Improvement, Satisfaction, and Challenges is depicted in Fig. 3. The usage of AI contributes positively to the improvement of writing skills ($\beta = 0.851$) and to satisfaction ($\beta = 0.392$).

Model fit is outstanding according to Table 9. The SRMR values for both saturated and estimated models, 0.032 and 0.034 respectively, are less than the critical value of 0.08, showing small residuals. High NFI values (0.930 - 0.932) above 0.90 and low d_ULS and d_G values further demonstrate the outstanding fit of the model and match between

Table 10. Hypothesis Testing Results

Path Relationship	Beta (Path Coefficient)	f-square (Effect Size)	p-value	Result	Hypothesis
AI Usage → Satisfaction	0.392	0.234	< 0.001	Supported	H1
AI Usage → Writing Skills Improvement	0.851	2.627	< 0.001	Supported	H2
Challenges → Satisfaction	-0.335	0.616	< 0.001	Supported	H3
Writing Skills Improvement → Satisfaction	0.509	0.394	< 0.001	Supported	H4

**Fig. 3.** Structural Model Path Diagram

the saturated and estimated models. All the research hypotheses have been tested and confirmed.

As shown in Table 10, all hypotheses have been empirically validated to be statistically significant. Specifically, AI Usage has a large positive impact on Writing Skills Improvement ($\beta = 0.851$, $f^2 = 2.627$, $p < 0.001$) and a medium positive influence on Satisfaction ($\beta = 0.392$, $f^2 = 0.234$, $p < 0.001$). He et al. [8] conducted a narrative review of 29 articles (2023-2025) on ChatGPT in ESL higher education, which showed that students developed better writing skills and grammatical accuracy and fluency skills through personalized feedback

4. Conclusion

The research demonstrates that AI feedback systems lead to better English writing results for college students. The PLS-SEM analysis verified the reliability and validity of 200 participants with AI usage having the maximum impact ($\beta = 0.851$). The advantages of the system are countered by two main problems which include plagiarism risks and diminished capacity for critical thinking. The study investigates AI integration for academic writing at one institution through self-reported data from participants. The research demonstrates how artificial intelligence integration into academic writing results in educational research outcomes

and technological development. For future research, a longitudinal study design and multiple institutions would be more effective in enhancing the generalizability of results. Furthermore, using mixed methods could give better insight into AI-enhanced writing and learning outcomes.

5. Declarations

- **Data Availability:** The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.
- **Conflicts of Interest:** The authors declare that they have no conflicts of interest regarding the publication of this paper.
- **Funding Statement:** This research was supported by the 2023 Research Project on Educational and Teaching Reform in Vocational Colleges of Hunan Province - Research and Practice on Aesthetic Education in "Public English" Course of Higher Vocational Colleges under the Context of Educational Digitalization (Project No. ZJGB2023099).
- **Author Contributions:** Lijuan Dai conceptualized the study, designed the research framework, conducted data analysis, and drafted the manuscript. Jiguo Yao contributed to methodology development, data collection, manuscript revision, and supervision. All authors reviewed and approved the final manuscript.
- **Ethical Approval:** This study was conducted in accordance with institutional and national ethical standards. Ethical approval was obtained from the relevant academic review committee of Hunan Modern Logistics College prior to data collection.
- **Consent to Participate:** Informed consent was obtained from all individual participants included in the study.
- **Consent to Publication:** All authors have read and approved the final manuscript and consent to its publication.

- **Competing Interests:** The authors declare that they have no competing interests.

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