An Innovative Contribution to Understanding Health Literacy and eHealth Literacy in Nursing Students: A Cross-Sectional Cluster Analysis

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Article

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Abstract

Background: HL and eHL are essential for future nurses. Their low levels in adults are linked to poorer outcomes and higher healthcare costs, emphasizing the need to assess these skills in nursing education. **Aim:** This study examined HL and eHL levels among nursing students across different years of a Bachelor of Nursing programme and identified subgroups of students. **Methods:** A cross-sectional study was conducted among students enrolled in all academic years. HL and eHL were assessed using the Health Literacy Questionnaire and the eHealth Literacy Scale (eHEALS). Descriptive statistics summarized participant characteristics and literacy levels. Differences across academic years were examined, and cluster analysis was performed to identify homogeneous student groups. **Results:** HL and eHL varied across the nursing curriculum. Four distinct clusters emerged: (1) older students, concurrently employed; (2) young, on-track second-year students; (3) students with prior university education; and (4) first-year students without an academic background. ANOVAs indicated significant differences in eight HL dimensions, with Cluster 2 consistently achieving the highest scores and Cluster 4 the lowest. **Conclusions:** HL and eHL among nursing students appear to be dynamic competencies shaped by sociodemographic and academic factors. Identifying student profiles supports the development of differentiated instructional strategies in nursing education. Although previous research has examined HL and eHL in nursing students, no study to date has defined these competencies in relation to the structure of the nursing curriculum or used cluster analysis to identify subgroups. This represents the main innovative contribution of the current study.

Keywords: Health Literacy; Digital Health Literacy; eHealth Literacy; nursing student; nursing education; cluster analysis; cross sectional study

1. Introduction

Health Literacy (HL) is becoming an increasingly prominent topic in the field of health promotion. According to the World Health Organization, HL represents a fundamental determinant of health and a global public health priority [1]. The World Health Organization defines health literacy as *"knowledge, motivation and competencies to access, understand, appraise and apply health information in order to make judgements and take decisions in every-day life concerning health care, disease prevention and health promotion to maintain or improve quality of life during the life programme"* [1].

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Recognized as a prerequisite for achieving equity, empowerment, and sustainability in healthcare, HL is now viewed as a critical component for strengthening health systems and improving population outcomes worldwide [2]. With the development of the science and technology, the concept of Electronic Health Literacy (eHL) has emerged—a pivotal competency in today's healthcare environment—referring to an *"individual's ability to access, understand, evaluate, and effectively use health-related information obtained through digital technologies"* [3]. This concept goes beyond mere technical proficiency, encompassing the ability to critically assess the credibility and reliability of online health information, and playing a crucial role in informed decision-making and self-management of health [4].

Research consistently shows low HL and eHL levels across many populations, which can limit access to health resources and worsen outcomes, increasing risks of complications, hospitalizations, and poor self-management [5,6]. Low eHL also reduces the ability to identify reliable online information and use digital tools effectively. Population ageing and the rise of chronic diseases highlight the need to strengthen HL and eHL to support patient autonomy and shared decision-making [7,8]. Improving these competencies can benefit both individuals and healthcare systems. Nurses play a central role in promoting HL and eHL, guiding patients through digital resources and care pathways [9,10]. However, nursing curricula often lack structured training on these competencies, and it is still unclear how students acquire them during their studies [8,11].

Previous research has revealed that nursing students often demonstrate insufficient or inadequate levels of HL [12–19]. Findings regarding eHL, however, are more heterogeneous. Holt et al. reported that graduate-level nursing students exhibit higher and satisfactory eHL levels compared to entry-level students [8], while Sharma et al. found that nursing students possess adequate internet skills and consider online information useful for health-related decision-making [20]. Similarly, Abou Hashish and Alnajjar observed that nursing students demonstrate good levels of eHL and strong digital competencies [21].

Despite these insights, there is still a lack of evidence on how HL and eHL levels evolve across different years of nursing education. Investigating the progression of these competencies throughout the programme could provide valuable information for developing targeted educational interventions aimed at enhancing both HL and DHL among future nurses.

In addition, it would be valuable to identify homogeneous subgroups of nursing students in order to analyze their specific characteristics. Recent studies have suggested that such subgroup profiling can provide meaningful insights into the diversity of students' competencies. For instance, Ning et al. identified three distinct profiles among university students—low, moderate, and high digital health literacy [22]—while Lima et al. found two groups with different HL levels and corresponding demographic and behavioral characteristics [23]. However, these studies included students from various academic disciplines rather than focusing exclusively on nursing students. Consequently, there is still no evidence regarding the existence and characteristics of homogeneous subgroups among nursing students. Identifying such profiles could support educators in designing tailored educational interventions to strengthen health literacy and digital health literacy competencies within nursing curricula. Considering the limitations in literature, this study aims to explore the levels of HL and eHL among nursing students in different years of the programme and to identify distinct subgroups of students using cluster analysis.

2. Materials and Methods

2.1. Study Design

A cross-sectional study was conducted. We used the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for reporting observational studies [24].

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2.2. Sample and Setting

A convenience sample of nursing students was recruited from an Italian university located on an island in southern Italy that offers a Nursing Degree Program. The university enrolls approximately 500 new students each year and has a current total of about 1,500 nursing students. Students from all years of the program who agreed to participate were included in the study.

2.3. Data Collection

The data collection was carried out during live meetings after university lessons, through a series of structured online surveys. The survey was administered between 1 and 30 April 2024. Two researchers (GB and IZ) explained the aim of the survey. They also provided the students with instructions. During the data collection period, the researchers were available to address any students' clarification requests, thereby ensuring consistency and accuracy in data collection.

2.4. Measurement

The initial section of the survey gathered sociodemographic information (gender, age, and nationality) along with data related to the participants' academic status. In the second part of the survey we used two instruments: the HLQ [25] to assess Health Literacy and the eHL Scale [3] to evaluate Electronic Health Literacy.

The HLQ [25] is a 44-item measure that captures the concept of Health Literacy across nine distinct domains (measured using one scale per domain). The nine scales are: 1) Feeling understood and supported by healthcare providers; 2) Having sufficient information to manage my health; 3) Actively managing my health; 4) Social support for health; 5) Appraisal of health information; 6) Ability to actively engage with healthcare providers; 7) Navigating the healthcare system; 8) Ability to find good health information; 9) Understanding health information enough to know what to do) [25]. Each of the nine scales contains between 4 and 6 items that are scored as a graded response. There are four response options for items in the first 5 scales: strongly disagree, disagree, agree and strongly agree. Scales 6–9 have a range of five possible responses: cannot do, very difficult, quite difficult, easy, and very easy. Scale scores were devised by summing the item scores and dividing by the number of items in the scale. Scale scores range between 1 and 4 for the first 5 scales, and 1 and 5 for scales 6 to 9. Each of the nine scales has been found to be highly reliable (composite reliability range from 0.8 to 0.9 for each of the 4- to 6-item scales) [25]. One-factor confirmatory factor analysis models using Bayesian structural equation modelling [26] confirmed the homogeneity of all scales [27].

The eHEALS [3] is a 10-item tool composed of two introductory items and eight core items. The first two items assess individuals' general perceptions of health information available on the internet, while the remaining eight items measure the combined knowledge, comfort, and perceived ability to find, evaluate, and apply electronic health information. Individuals can assess their agreement/disagreement through a five-point Likert scale ranging from "strongly disagree" to "strongly agree", with a score from 1 to 5 for each item for the 8 items thus, the scores could range from a minimum of 8 to a maximum of 40, with higher scores representing higher levels of eHL. For the first two items the Likert scale ranges from "Not useful at all" to "Very Useful" (item 1) and "Not important at all" and "Very important" (Item 2). Psychometric assessment for eHEALS showed a Cronbach's alpha of 0.86, while a single factor solution with a value 4.48 (56% of variance explained) was obtained from principal component analysis. The test-retest reliability showed limited stability over time from baseline to 3 months of follow-up, with a Pearson correlation coefficient of 0.467 [3]. We used the Italian translation of the eHEALS by De Caro et al., [28] with the permission of the authors. De Caro et colleagues assessed the reliability and validity of the instrument with a sample of 737 subjects of different Facebook groups, excluding health professionals [28]. De Caro et al. [28] reported a reliability of 0.862 (Alpha di Cronbach) and performed an exploratory factor analysis. The total amount of variance explained by the factor is 46.69% of the total variance.

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2.5. Data Analysis

The statistical analyses were performed with SPSS Statistics version 27.0 (IBM Corp.). Continuous variables were presented as mean, standard deviation [SD] and range. Categorical variables were presented as absolute frequency and percentage (%).

For each participant, the following socio-demographic and academic variables were collected: year of study (1st, 2nd, 3rd), previous university education (dichotomous), earned ECTS credits (continuous), employment status (dichotomous: employed vs. not employed), program choice (first choice vs. not first choice), marital status (categorical), age (in years), presence of children (dichotomous), gender (categorical), and weighted grade point average (continuous).

To test differences in categorical variables with more than two classes, a one-way analysis of variance (ANOVA) model was applied. All the required assumptions for the ANOVA model were evaluated. A Bonferroni correction of the p value was performed for pairwise comparisons. Normal distribution was evaluated visually by the Normal Q-Q plot. A p value of < 0.05 was considered statistically significant.

An exploratory Two-Step Cluster Analysis was conducted to identify heterogeneous student profiles and classify participants into homogeneous subgroups based on the set of mixed variables described above [29]. The model included the following predictors: year of study, previous university attendance, completion of prior university studies, number of ECTS credits earned, employment status, first-choice programme selection, marital status, age, presence of children, gender, and weighted Grade Point Average (GPA). The log-likelihood distance measure was selected, consistent with standard recommendations for Two-Step clustering, as it accommodates mixed data distributions (categorical variables treated as discrete probability distributions and continuous variables assumed to follow normal distributions). The optimal number of clusters was automatically determined using the Bayesian Information Criterion (BIC), and the algorithm retained the best-fitting solution. The procedure consisted of two sequential phases: (1) a pre-clustering step that generated small subclusters using a sequential clustering approach, followed by (2) hierarchical clustering applied to the pre-clusters to obtain the final cluster solution. Model adequacy was evaluated through the silhouette coefficient, cluster size distribution, and theoretical interpretability of the resulting profiles.

For each cluster, descriptive statistics were computed, including means and standard deviations for continuous variables and absolute/percentage frequencies for categorical variables. Variables contributing most strongly to cluster formation (predictor importance) were identified and reported.

After deriving the final cluster structure, clusters were profiled in relation to HL and eHL level. Group differences across clusters were assessed using one-way Analysis of Variance (ANOVA) for continuous variables and chi-square tests for categorical variables. When significant main effects were observed, post hoc pairwise comparisons were conducted using Bonferroni correction. Statistical significance was set at $p < 0.05$.

2.6. Ethical Issues

This study was carried out in accordance with the principles outlined in the Declaration of Helsinki. The research protocol was approved by the Internal Review Board of the Nursing Degree *(Department Council of 19 October 2022, agenda item No. 43)*. Prior to completing the questionnaire, all participants were informed about the objectives of the study. They were assured that their responses would remain anonymous and that all data would be analyzed in aggregate form. Informed consent was obtained from each participant, including their agreement to the publication of the study's findings.

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3. Results

3.1. Sample Characteristics

The sample was composed of 1,500 students enrolled in the Nursing Bachelor's Degree program at a university on an island in southern Italy. A total of 600 students (40.0%) responded to the questionnaire. The mean age of the sample was 22.5 years (± 5.08); 75.3% were female, 88.3% were single, and 4.2% had children. Overall, 19.3% were working while attending the program, and 6.5% of them were employed in a healthcare setting. Regarding academic variables, 65.5% of the nursing students declared Nursing as their first choice, while the other declared choices were Physiotherapy (18.4%), Midwifery (23.6%), Speech Therapy (5.3%), and Medicine (24.2%). A total of 24.7% of the students had attended previous university programmes. The weighted mean grade for the overall sample was 24.7 (± 1.9; range 18 – 29.1). By year of study, the mean grade was 24.1 (± 2.1; 18 – 28.7) in the 1st year, 25.1 (± 1.6; 19.1 – 29.0) in the 2nd year, and 25.4 (± 1.3; 22.5 – 29.1) in the 3rd year. Among 60 CFU (Universitary Credit = European Credit Transfer and Accumulation System) for every year of the programme (180 CFU for the degree), the students at the time of the data collection (on Aprile, 2024) have attended in overall sample 46.9 (± 28.3, 5 - 135) ECTS, 21.9 (± 7.2, 5.0 – 79.0) at the 1st, 60.5 (± 14.6, 10.0 – 79.0) at the 2nd, 98.9 (± 25.4, 27.0 – 135.0) at the 3rd year of the programme. All the characteristics are included in Table 1.

Table 1. The characteristics of the sample.

Sociodemographic variables		**N (%)**
Year of the programme	1st year	268 (44.7)
	2nd year	274 (45.7)
	3rd year	58 (9.7)
Gender	Female	452 (75.3)
	Male	148 (24.7)
Age mean (± standard deviation, range)	22.5 (5.08, 18-53)	
Marital status	Single	530 (88.3)
	Divorced/separated	4 (0.7)
	Married/ cohabiting	65 (10.8)
	Widower	1 (0.2)
Children	No	575 (95.8)
	Yes	25 (4.2)
Number of children	One	12 (2.0)
	Two	12 (2.0)
	Three or more	1 (0.2)
Work during the program	No	484 (80.7)
	Yes	116 (19.3)
Nursing degree as a first choice	No	207 (34.5)
	Yes	393 (65.5)
Others choice	Physiotherapy	38 (18.4)
	Midwifery	49 (23.6)
	Speech therapist	11 (5.3)
	Medicine	50 (24.2)

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	Others	59 (28.5)
Previous university education	No	452 (75.3)
	Yes	148 (24.7)
Weighted mean of grade for overall sample	24.7 (± 1.9, 18- 29.1)	
Weighted mean of grade for 1st year of the programme	24.1 (± 2.1, 18.0 - 28.7)	
Weighted mean of grade for 2nd year of the programme	25.1 (± 1.6, 19.0 – 29.0)	
Weighted mean of grade for 3rd year of the programme	25.4 (± 1.3, 22.5 - 29.1)	
ECTS attended mean (± standard deviation, range) **for overall sample**	46.9 (± 28.3, 5-135)	
ECTS attended mean (± standard deviation, range) 1st year	21.9 (± 7.2, 5.0 – 79.0)	
ECTS attended mean (± standard deviation, range) 2nd year	60.5 (± 14.6, 10.0 – 79.0)	
ECTS attended mean (± standard deviation, range) 3rd year	98.9 (± 25.4, 27.0 -135.0)	

3.2. Health Literacy Level in Nursing Students

Among the dimensions with a Likert scale ranging from 1 to 4 (scales 1–5) (strongly disagree = 1, disagree = 2, agree = 3, strongly agree = 4), the dimensions showing higher scores were "Social support for health" (mean 3.11 ± 0.45) and "Appraisal of health information" (mean 3.12 ± 0.38). The lowest score was observed for "Feeling understood and supported by healthcare professionals" (mean 2.98 ± 0.53). Among the dimensions with a Likert scale ranging from 1 to 5 (scales 6–9) (cannot do = 1, very difficult = 2, quite difficult = 3, easy = 4, very easy = 5), the dimension with the highest score was "Understanding health information well enough to know what to do" (mean 3.65 ± 0.49). The lowest score was found for "Navigating the health care system" (mean 3.33 ± 0.51) (Table 2).

Table 2. The Health Literacy Questionnaire (Osborne et al., 2013) score for overall sample.

Dimensions	**Mean (SD) [range]**
1. Feeling understood and supported by healthcare professionals	2.98 (0.53) [1 – 4]
2. Having sufficient information to manage my health	2.96 (0.41) [1.75 – 4]
3. Actively managing my health	2.98 (0.46) [1.40 - 4]
4. Social support for health	3.11 (0.45) [1.40 - 4]
5. Appraisal of health information	3.12 (0.38) [1.60 - 4]
6. Ability to actively engage with healthcare professionals	3.47 (0.55) [1.40 - 5]
7. Navigating the healthcare system	3.33 (0.51) [1.67 - 5]
8. Ability to find good health information	3.46 (0.47) [1.80 - 5]
9. Understand health information enough to know what to do	3.65 (0.49) [1.80 - 5]

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3.3. Differences in Health Literacy Level Among the Year of the Course

There were statistically significant differences in dimension 1, Feeling understood and supported by healthcare professionals, between the 1st and 2nd year ($p = 0.002$) and between the 1st and 3rd year of the programme ($p = 0.004$); in dimension 3, Actively managing my health, between the 1st and 2nd year ($p < 0.001$); in dimension 4, Social support for health, between the 1st and 2nd year ($p < 0.001$) and between the 1st and 3rd year of the programme ($p < 0.001$); in dimension 5, Appraisal of health information, between the 1st and 2nd year ($p < 0.001$); and finally in dimension 6, Ability to actively engage with healthcare professionals, between the 1st and 2nd year ($p < 0.001$) and between the 1st and 3rd year of the programme ($p = 0.003$) (Table 3).

Table 3. The Health Literacy Questionnaire (Osborne et al., 2013) score in the years of the programme.

		Mean (SD) [range]	F	p value	1st vs 2nd year	1st vs 3rd year	2nd vs 3rd year
1.	**Feeling understood and supported by healthcare professionals**	**2.98 (0.53) [1.00 – 4.00]**					
	1st year	3.07 (0.54) [1.50 – 4.00]					
	2nd year	2.92 (0.52) [1.0 – 4.00]	8.51	< 0.001	0.002	0.004	0.662
	3rd year	2.83 (0.52) [1.50 – 4.00]					
2.	**Having sufficient information to manage my health**	**2.96 (0.41) [1.75 – 4.00]**					
	1st year	2.99 (0.43) [1.75 – 4.00]					
	2nd year	2.93 (0.40) [1.75 – 4.00]	1.93	0.146	0.150	1.000	1.000
	3rd year	2.96 (0.38) [1.75 – 3.75]					
3.	**Actively managing my health**	**2.98 (0.46) [1.40 – 4.00]**					
	1st year	3.06 (0.44) [1.40 – 4.00]					
	2nd year	2.92 (0.48) [1.60 – 4.00]	7.31	< 0.001	< 0.001	0.158	1.000
	3rd year	2.93 (0.35) [2.00 – 3.80]					
4.	**Social support for health**	**3.11 (0.45) [1.40 – 4.00]**					
	1st year	3.22 (0.45) [1.40 – 4.00]					
	2nd year	3.04 (0.45) [1.60 – 4.00]	16.37	< 0.001	< 0.001	< 0.001	0.599
	3rd year	2.96 (0.36) [1.60 – 3.80]					
5.	**Appraisal of health information**	**3.12 (0.38) [1.60 – 4.00]**					
	1st year	3.19 (0.41) [1.60 – 4.00]					
	2nd year	3.06 (0.36) [1.80 – 4.00]	7.57	< 0.001	< 0.001	0.214	1.000
	3rd year	3.08 (0.29) [2.00 – 3.80]					
6.	**Ability to actively engage with**	**3.47 (0.55) [1.40 – 5.00]**					

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	healthcare professionals						
	1st year	3.57 (0.56) [1.80 – 5.00]					
	2nd year	3.40 (0.54) [1.40 – 5.00]	9.57	< 0.001	< 0.001	0.003	0.894
	3rd year	3.32 (0.51) [2.20 – 5.00]					
7.	**Navigating the healthcare system**	**3.33 (0.51) [1.67 – 5.00]**					
	1st year	3.38 (0.52) [1.67 – 5.00]					
	2nd year	3.30 (0.51) [1.67 – 5.00]	2.66	0.071	0.220	0.165	1.000
	3rd year	3.24 (0.46) [2.17 – 4.67]					
8.	**Ability to find good health information**	**3.46 (0.47) [1.80 – 5.00]**					
	1st year	3.48 (0.48) [1.80 – 5.00]					
	2nd year	3.45 (0.47) [2.00 – 5.00]	0.62	0.536	1.000	0.973	1.000
	3rd year	3.42 (0.47) [2.40 – 4.80]					
9.	**Understand health information enough to know what to do**	**3.65 (0.49) [1.80 – 5.00]**					
	1st year	3.68 (0.48) [2.40 – 5.00]					
	2nd year	3.63 (0.50) [1.80 – 5.00]	0.92	0.398	0.667	1.000	1.000
	3rd year	3.62 (0.48) [3.00 – 4.80]					

3.4. Electronic Health Literacy Level Among Nursing Students

The verification of the assumptions underlying the ANOVA test required the elimination of outliers (4.8%, n = 29) from an initial sample of 600 students who had response values excessively distant from what was expected. The final statistical analysis was performed on a sample of 571 participants.

The instrument also included two other items; in item “How useful do you feel the Internet is in helping you in making decisions about your health?” [1.88 (0.84), 0 - 4]; and “How important is it for you to be able to access health resources on the Internet?” [2.38 (0.84), 0-4]. In the eHL Scale Individuals can assess their agreement/disagreement through a five point Likert scale ranging from "strongly disagree" to "strongly agree", with a score from 1 to 5 for each item for the 8 items thus, the scores could range from a minimum of 8 to a maximum of 40, with higher scores representing higher levels of eHL. The item that shows higher score is “I can tell high quality health resources from low quality health resources on the Internet” (mean 2.84, ± 0.77), the item “I know how to use the Internet to answer my questions about health” (mean 2.79, ± 0.69), and “I know what health resources are available on the Internet” (mean 2.78, ± 0.78). The lower score was shown by “I feel confident in using information from the Internet to make health decisions” (mean 2.08, ± 1.03). (Table 4)

Table 4. The eHealth Literacy Scale (Norman & Skinner, 2006) for overall sample.

		Mean (SD) [range]
1.	I know what health resources are available on the Internet	2.78 (0.78), [0 - 4]
2.	I know where to find helpful health resources on the Internet	2.71 (0.76), [0 - 4]
3.	I know how to find helpful health resources on the Internet	2.73 (0.67), [0 - 4]

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4. I know how to use the Internet to answer my questions about health	2.79 (0.69), [0 - 4]
5. I know how to use the health information I find on the Internet to help me	2.46 (0.88), [0 - 4]
6. I have the skills I need to evaluate the health resources I find on the Internet	2.74 (0.76), [0 - 4]
7. I can tell high quality health resources from low quality health resources on the Internet	2.84 (0.77), [0 - 4]
8. I feel confident in using information from the Internet to make health decisions	2.08 (1.03), [0 - 4]
Overall score	2.64 (0.57), [1 - 4]

3.5. Differences in eHealth Literacy Level Among the Year of the Programme

There are statistically significant differences in item 5, "I know how to use the health information I find on the Internet to help me," between the 1st and 2nd year ($p = 0.035$); in item 6, "I have the skills I need to evaluate the health resources I find on the Internet," between the 1st and 2nd year ($p < 0.001$); and in item 8, "I feel confident in using information from the Internet to make health decisions," between the 1st and 2nd year ($p = 0.012$) and between the 1st and 3rd year ($p = 0.019$). There are statistically significant differences in the overall score between the 1st and 2nd year ($p = 0.018$). (Table 5)

Table 5. The eHealth Literacy Scale (Norman & Skinner, 2006) score in the years of the programme.

	Mean (SD) [range]	**F (p value)**	**1st vs 2nd year**	**1st vs 3rd year**	**2nd vs 3rd year**
I know what health resources are available on the Internet	2.78 (0.78), [0 - 4]				
1st year	2.74 (0.84), [1 - 4]	0.732 (0.482)	0.244	0.514	0.113
2nd year	2.82 (0.70), [1 - 4]				
3rd year	2.81 (0.78), [1 - 4]				
I know where to find helpful health resources on the Internet	2.71 (0.76), [0 - 4]				
1st year	2.68 (0.85), [1 - 4]	0.363 (0.696)	0.395	0.805	0.787
2nd year	2.74 (0.65), [1 - 4]				
3rd year	2.71 (0.86), [1 - 4]				
I know how to find helpful health resources on the Internet	2.73 (0.67), [0 - 4]	0.319 (0.727)	0.470	0.590	0.922
1st year	2.71 (0.73), [1 - 4]				

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2nd year	2.75 (0.61), [1 - 4]				
3rd year	2.76 (0.63), [1 - 4]				
I know how to use the Internet to answer my questions about health	2.79 (0.69), [0 - 4]				
1st year	2.75 (0.74), [1 - 4]	0.882 (0.414)	0.185	0.652	0.723
2nd year	2.83 (0.62), [1 - 4]				
3rd year	2.79 (0.69), [1 - 4]				
I know how to use the health information I find on the Internet to help me	2.46 (0.88), [0 - 4]				
1st year	2.37 (0.93), [1 - 4]	2.363 (0.095)	0.035	0.262	0.872
2nd year	2.54 (0.84), [1 - 4]				
3rd year	2.52 (0.80), [1 - 4]				
I have the skills I need to evaluate the health resources I find on the Internet	2.74 (0.76), [0 - 4]				
1st year	2.63 (0.87), [1 - 4]	5.806 (0.003)	< 0.001	0.370	0.242
2nd year	2.85 (0.61), [1 - 4]				
3rd year	2.72 (0.74), [1 - 4]				
I can tell high quality health resources from low quality health resources on the Internet	2.84 (0.77), [0 - 4]				
1st year	2.81 (0.84), [1 - 4]	0.552 (0.576)	0.294	0.776	0.724
2nd year	2.88 (0.69), [1 - 4]				
3rd year	2.84 (0.72), [1 - 4]				
I feel confident in using information from the	2.08 (1.03), [0 - 4]	4.605 (0.010)	0.012	0.019	0.415

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Internet to make health decisions					
1st year	1.94 (1.11), [1 - 4]				
2nd year	2.17 (0.96), [1 - 4]				
3rd year	2.29 (0.89), [1 - 4]				
Overall score	2.64 (0.57), [1 - 4]				
1st year	2.57 (0.65), [1 - 4]	2.969 (0.052)	0.018	0.213	1.000
2nd year	2.69 (0.46), [1 - 4]				
3rd year	2.68 (0.60), [1 - 4]				

3.6. Definition of Group of Students

We performed a Two-Step Cluster Analysis to identify distinct student profiles based on a combination of socio-demographic and academic variables. The results of the cluster analysis show 4 distinct clusters (Table 6). The model adequacy showed a fair silhouette coefficient, cluster size distribution was well balanced and theoretical interpretability of the resulting profiles were robust.

Seven students had missing data and were therefore excluded from the two steps cluster analysis, resulting in a final analytic sample of 564 nursing students.

Cluster 1 – "Second-year students, older in age, with partial active employment."

This cluster comprises 24.3% of the sample (n = 137). It includes 19.7% (n = 27) 1st year student, 49.6% (n = 68) 2nd year students, 30.7% (n = 42) of the 3rd year students, A small proportion (2.19%, n = 3) have previous university education and all of them had completed their prior degree. Nearly half of the students in this cluster (47.4%, n = 65) were employed while attending the programme.. Nursing was the first choice degree for 69.3% (n = 95). The majority were single (81.0%, n = 111), 13.1% (n = 18) had children, 54.0% (n = 74) were male. The mean age within this cluster was 24.78 years (SD = 7.14). The mean weighted academic grade was 24.62 (± 1.92) and the average number of ECTS completed was 63.38 (± 31.94).

Cluster 2 – "Young second-year students, female and very consistent/regular and without a university background".

This cluster represents 24.5% of the sample (n = 138). It consists of 5.79% (n = 8) 1st year students, 94.2% (n = 130) 2nd year students, and 0.0% (n = 0) 3rd year students. All partecipants in this cluster have no previous university education (100%) and are not currently employed (100%). For 59.42% (n = 82), nursing was the first choice career. Among the students in this cluster,83.3% (n = 115) are single; The cluster mean age of 20.76 years (± 1.54). Additionally, 100% (n = 138) are female and have no children. The mean weighted grade is 25.03 (± 1.55), and the mean number of ECTS attended is 58.86 (± 16.52).

Cluster 3 – "Students with prior education, older in age, and with a pathway not yet completed".

This cluster encompasses 24.6% of the sample (n = 139). It includes 52.5% (n = 73) 1st year students 37.4% (n = 52) 2nd year students, and 10.1% (n = 14) 3rd year students. All partecipants in this cluster (100%, n = 139) have prior university education, with 17.3% (n = 24) having completed their previous studies. Additionally, 25.9% (n = 36) were employed. Nursing was the first choice career for 65.5% (91). The mean age of students in this cluster is 24.44 years (± 4.90), with 80.6% (n =

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112) being female, 2.16 (n = 3), and 90.6% (n = 126) being single. The mean weighted grade is 24.70 (± 1.96) and the mean number of ECTS credits attended is 45.72 (± 29.73).

Cluster 4 - "First-year students without a university background, highly consistent/regular".

This cluster accounts for 26.6% of the sample (n = 150). It consists solely of1st year students, all of whom have no prior university education and are not employed. Nursing was the first choice career for 67.3% (n = 101). The mean age of students in this cluster was 20.06 years (± 2.24), and 75.3% (n = 113) were female. None of the students in this cluster have children. The mean weighted grade is 24.30 (± 1.95) and the mean number of ECTS credits attended is 21.26 (± 5.98).

Table 6. Cluster Analysis among nursing students.

Variables	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Nursing students	24.3% (137)	24.5% (138)	24.6% (139)	26.6% (150)
Female	45.9% (63)	100% (138)	80.6% (112)	75.3% (113)
Years of the programme				
1st year	19.7% (27)	5.8% (8)	52.5% (73)	100% (150)
2nd year	49.6% (68)	94.2% (130)	37.4% (52)	-
3rd year	30.7% (42)	-	10.1% (14)	-
Previous university education	11.1% (3)	-	100% (139)	-
Previous university education concluded	2.19% (3)	-	17.3% (24)	-
Work	47.7% (65)	-	25.9% (36)	-
Nursing as a first choice	69.3% (95)	59.4% (82)	65.5% (91)	67.3% (101)
Single	81% (111)	83.3% (115)	90.6% (126)	100% (150)
Children	13.1% (18)	-	2.16% (3)	-
Age	24.78 ± 7.14	20.76 ± 1.54	24.44 ± 4.90	20.06 ± 2.24
Weighted mean grade	24.61 ± 1.92	25.03 ± 1.55	24.70 ± 1.96	24.30 ± 1.95
ECTS attended	63.37 ± 31.93	58.96 ± 16.52	45.72 ± 29.73	21.36 ± 5.98
HL Dimension 1	2.94 ± 0.58	2.83 ± 0.49	3.05 ± 0.53	3.09 ± 0.48
HL Dimension 2	3.02 ± 0.39	2.87 ± 0.40	2.96 ± 0.39	2.98 ± 0.42
HL Dimension 3	2.98 ± 0.44	2.86 ± 0.45	2.99 ± 0.45	3.08 ± 0.42
HL Dimension 4	3.03 ± 0.42	3.05 ± 0.42	3.12 ± 0.47	3.24 ± 0.42
HL Dimension 5	3.10 ± 0.37	3.01 ± 0.33	3.17 ± 0.38	3.18 ± 0.37
HL Dimension 6	3.53 ± 0.50	3.33 ± 0.51	3.43 ± 0.58	3.63 ± 0.51
HL Dimension 7	3.41 ± 0.48	3.23 ± 0.46	3.26 ± 0.48	3.43 ± 0.50
HL Dimension 8	3.52 ± 0.46	3.35 ± 0.42	3.49 ± 0.45	3.50 ± 0.46
HL Dimension 9	3.70 ± 0.66	3.58 ± 0.42	3.68 ± 0.51	3.66 ± 0.47
eHL total score	2.69 ± 0.59	2.59 ± 0.42	2.73 ± 0.57	2.55 ± 0.64

Frequency n (%); Means ± Standard deviation.

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The HL and eHL score in every dimension are shown in Table 5. About HL level there are statistical differences in Dimension 1 "Feeling understood and supported by healthcare professionals" between cluster 2 and 3 ($p = 0.004$) and cluster 2 and 4 ($p < 0.001$); in Dimension 2 "Having sufficient information to manage my health" between cluster 1 and 2 ($p = 0.014$); in Dimension 3 "Actively managing my health" between cluster 2 and 4 ($p < 0.001$); in Dimension 4 "Social support for health" between cluster 1 and 4 ($p < 0.001$) and cluster 2 and 4 ($p < 0.001$); in Dimension 5 "Appraisal of health information" between cluster 2 and 3 ($p < 0.001$) and cluster 2 and 4 ($p < 0.001$); in Dimension 6 "Ability to actively engage with healthcare professionals" between cluster 1 and 2 ($p = 0.012$), between cluster 2 and 4 ($p < 0.001$), and between cluster 3 and 4 ($p = 0.007$); in Dimension 7 "Navigating the health care system" between cluster 1 and 2 ($p = 0.019$), cluster 3 and 4 (0.019); in Dimension 8 "Ability to find good health information" between cluster 1 and 2 ($p = 0.010$), and cluster 2 and 4 ($p = 0.030$). No differences in Dimension 9 "Understand health information enough to know what to do" and eHL level.

4. Discussion

This study aimed to assess the levels of HL and eHL among nursing students, examine how these competencies change across the three years of the programme and identify distinct clusters of students to explore their demographic and educational characteristics. This is the first Italian study involving nursing students that has identified distinct profiles, which may assist educators in recognizing students' needs and supporting the development of HL and eHL competencies. In our study the sociodemographic characteristics of the sample reflect the typical profile of nursing students internationally, as reported in other studies exploring HL and eHL levels among university students [8,30,31]. The findings show that nursing students exhibit varying levels of HL and eHL throughout the programme, and cluster analysis identified four distinct profiles differing in academic stage, prior education, working status, and health literacy patterns, with notable variations in social support, engagement with healthcare professionals, and ability to find health information.

4.1. The Health Literacy Level in Nursing Students

The overall HL score indicates a moderate to high level of HL across the sample. Mean values for the nine HLQ dimensions ranged from 2.96 to 3.65, suggesting that students generally demonstrate adequate competencies in understanding, and managing, their health needs. Dimensions related to interaction with the healthcare system, such as the "Ability to actively engage with healthcare professionals" (mean 3.47) and "Ability to find good health information" (mean 3.46), were among the highest-scoring domains. These findings suggest that students perceive substantial interpersonal support and possess satisfactory critical appraisal skills, consistent with previous studies [17,32,33]. Conversely, "Having sufficient information to manage my health" (mean 2.96) and "Actively managing my health" (mean 2.98) showed comparatively lower, though still adequate, values, indicating potential areas where students may feel less empowered to take autonomous action or may perceive gaps in the information available to them. Similar patterns have been reported by Holt et al. [8] and Balmer et al. [14]. Across the three years of study, first-year students consistently reported higher HL levels compared with their senior peers. This pattern may be partly attributable to the curriculum structure: early programmes typically emphasize preventive health, healthy lifestyles, and the identification of reliable health information sources, which may strengthen students' perceived competencies in several HLQ domains. Furthermore, first year students often maintain closer ties with family and pre-existing support networks, which may enhance their perceptions of social support, understanding by healthcare professionals, and their ability to actively manage their health. As students progress through the programme and encounter increasing academic and clinical demands, these perceptions may decline, contributing to the lower scores observed in later years.

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4.2. The eHealth Literacy Level in Nursing Students

In relation to eHL level, items such as "I can tell high-quality health resources from low-quality health resources on the Internet" (mean = 2.84) and "I know what health resources are available on the Internet" (mean = 2.78) were among the highest-scoring. These results suggest an adequate capacity to locate and recognize trustworthy digital health information. In contrast, lower scores were observed in competencies related to applying online health information. The items "I feel confident in using information from the Internet to make health decisions" (mean = 2.08) and "I know how to use the health information I find on the Internet to help me" (mean = 2.46) showed the lowest means, highlighting weaker confidence in transforming information into action. These findings suggest that while students possess reasonably developed skills in identifying, locating, and evaluating online health information, they demonstrate less certainty when applying this information to guide health behaviors or decisions. This pattern aligns with findings from previous research showing that younger populations often feel proficient in digital navigation but may lack deeper critical or decision-making skills related to eHL [8,22,34]. There are differences between 1st- and 2nd-year students in their knowledge of how to use health information, their ability to evaluate health resources, and their capacity to apply this information to decisions about their health. Second-year students showed greater competence in these areas, likely reflecting the influence of academic exposure and developing critical appraisal skills. These findings highlight the importance of integrating eHL training early into the curriculum to support informed decision-making.

4.3. Cluster Analysis

The cluster analysis revealed four distinct student profiles shaped by academic trajectory, age, and employment status. Cluster 1 includes older, partially employed second-year students who maintain satisfactory progress despite extra-academic responsibilities and represent a non-traditional student group. Cluster 2 comprises young, highly regular second-year students with the highest GPA, depicting an ideal and uninterrupted academic path. Cluster 3 consists of older students with prior university experience who show academic maturity but a less linear progression, with credits distributed across the first and second years. Cluster 4 represents young, first-year students without prior university background, showing regular progression and strong academic performance typical of newly enrolled students.

Analysis of HL dimensions across the four clusters revealed clear differences that mirror students' demographic and academic profiles. While eHL did not vary among groups, several HL dimensions showed significant contrasts. Cluster 2 consistently scored highest in multiple HL dimensions, suggesting greater confidence, autonomy, and engagement with health information. In contrast, Clusters 1 and 3, showed lower scores in several HL dimensions. Cluster 3 displayed challenges in perceiving support from healthcare professionals and appraising health information, while Cluster 1 showed reduced social support and greater difficulty navigating the healthcare system, consistent with the known constraints faced by working adults. Cluster 4, composed of young first-year students, scored lower than Cluster 2 in several dimensions, possibly reflecting limited exposure to health systems. Overall, the findings show that HL is strongly influenced by age and academic continuity.

Lima et al. [23] also identified a student cluster with the highest HL scores, characterized by a predominance of female students, older age (mean 29.59 years), and enrollment in nursing programs compared to pharmacy. In contrast, in our study, Cluster 2, similarly achieving the highest HL scores, was predominantly female but notably younger (mean 20.76 years). This difference suggests that while gender may consistently relate to higher HL, age may interact differently depending on the academic context and student population.

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Limitations

This study has some limitations. First, this is a monocentric study and reflects self-reported data (Polit & Tatano, 2017). Another limitation is that the findings are context-dependent therefore the finding cannot be generalized.

Implications for Research and Education

The findings of this study suggest some implications for research and education. For research it could be interesting to conduct longitudinal tracking of HL and eHL to analyzing changes in health literacy across different academic stages, to better understand how student trajectories and life circumstances influence HL development. Other implications are related to the motivation as certain HL and eHL dimensions vary across clusters while others remain stable. Lastly, the four identified student profiles provide a framework for comparing educational outcomes, such as drop-out risks, and academic success. About educational implications, educators can design interventions based on cluster-specific needs, e.g., performance enhancement for traditional students (Clusters 2 and 4) and flexible, adaptive support for non-traditional students (Clusters 1 and 3). Moreover, it is necessary to integrate HL and eHL into the curriculum to reduce disparities between student groups and foster autonomous engagement with health information.

Conclusion

This study provides a detailed overview of the HL and eHL levels of Italian nursing students, showing variations across academic years and distinct student profiles. Students generally demonstrated moderate to high HL, with strengths in engaging with healthcare professionals and evaluating health information, while autonomous health management and the application of digital information were comparatively weaker. Differences between first- and second-year students suggest that academic progression and exposure to curriculum content enhance critical appraisal and information-use skills, highlighting the importance of integrating HL and eHL training early in the programme.

Cluster analysis identified four profiles influenced by age, academic stage, and employment status, indicating that HL is shaped by both demographic and educational factors, whereas eHL appears more stable. Although previous studies have examined HL and eHL in nursing students, none have clearly related these competencies to curriculum structure or applied cluster analysis to define student subgroups. This represents the principal innovative contribution of the present study.

These findings have important implications for nursing education. Tailored interventions could support students with specific literacy needs, and embedding HL and eHL throughout the curriculum may strengthen competencies essential for informed health decision-making. Future research, especially longitudinal studies, is needed to track changes in HL and eHL over time and to assess the impact of targeted educational strategies.

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Abbreviations

The following abbreviations are used in this manuscript

BIC	Bayesian Information Criterion
ECTS	European Credit Transfer and Accumulation System
eHLS	Electronic Health Literacy Scale
eHL	Electronic Health Literacy
HL	Health Literacy
HLQ	Health Literacy Questionnaire

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