

## Purpose

- Human anatomy and physiology are considered a cornerstone of health-related professional education and serve as a prerequisite for future nursing courses (McVicar et al., 2015). However, emerging evidence suggests that there is great difficulty not only in transferring fundamental anatomical knowledge to theory/clinical application but also a loss of knowledge over time (Narnaware & Neumeier, 2020, 2021).
- We have previously shown that the second-and third-year nursing students lose approximately 29.0% and 31.0% of their first-year anatomical knowledge, retaining about 71.0% and 69.0% within two years (Narnaware and Neumeier, 2020; Narnaware and Neumeier, 2020b). However, anatomical knowledge transfer/loss, retention, and application in fourth-year nursing students have not been assessed yet.

## Methods

- This study was conducted in the Fall 2018 semester with a class of 25-30 fourth year nursing students. Quizzes were created using an online quizzing platform called Kahoot (Kahoot Inc., Oslo, Norway) to assess knowledge retention. The quizzes were not used for marks, and students were encouraged not to study for them in advance. Between nine and eleven multiple-choice questions reflecting first year knowledge from each major organ system were developed into eleven Kahoots.
- The pooled data from the first-year anatomy course and the fourth-year course were subjected to statistical evaluation using SPSS II (IBM Corp; Armonk, NY) to determine overall knowledge loss. Means were compared using 2-sample 't' tests. Significant differences were considered at  $P < 0.05$ .

## Results

- The mean score for all organ systems in year one was  $83.05 \pm 8.34$  (SD) which was significantly decreased to  $53.9 \pm 9.4$  (SD) by the fourth-year nursing course. This equates to a 29.6% knowledge loss and 70.4% retention within four years (Figure 1).
- The organ system-specific loss was observed.
- Knowledge loss was highest for the head and lymphatics, cranial nerves, lymphatic and special senses (37-56%). This was followed by the integumentary, vascular, musculo-skeletal and nervous systems (25-28%).
- Loss was significantly lowest ( $P < 0.001$ ) for the genitourinary, respiratory and gastrointestinal systems (12-21%) (Table 1).

**Table 1. Anatomical Knowledge Loss by Organ System**

| Organ system          | Year 1<br>Mean $\pm$ SD | Year 4<br>Mean $\pm$ SD | % Know.<br>Loss | P-<br>Values |
|-----------------------|-------------------------|-------------------------|-----------------|--------------|
| Integumentary system  | 90.6 $\pm$ 6.8          | 62.4 $\pm$ 26.3         | 28.2%           | .0001        |
| Head & neck lymphatic | 91.4 $\pm$ 11.7         | 35.7 $\pm$ 18.9         | 55.7%           | .0001        |
| Special Senses        | 88.4 $\pm$ 6.9          | 51.4 $\pm$ 24.6         | 37.0%           | .0001        |
| Gastrointestinal      | 63.6 $\pm$ 6.9          | 51.58 $\pm$ 17.7        | 12.0%           | .0001        |
| Respiratory system    | 72.9 $\pm$ 5.8          | 58.92 $\pm$ 18.3        | 13.9%           | .0001        |
| Vascular system       | 83.5 $\pm$ 5.4          | 55.9 $\pm$ 25.6         | 27.6%           | .0001        |
| Nervous system        | 83.9 $\pm$ 8.1          | 58.8 $\pm$ 15.9         | 25.1%           | .0001        |
| Cranial nerves        | 88.2 $\pm$ 4.4          | 44.1 $\pm$ 20.4         | 44.1%           | .0001        |
| Musculo-skel. System  | 88.0 $\pm$ 7.0          | 61.4 $\pm$ 21.3         | 26.6%           | .0002        |
| Lymphatic system      | 82.6 $\pm$ 2.8          | 45.0 $\pm$ 18.6         | 37.6%           | .0001        |
| Genitourinary system  | 80.4 $\pm$ 16.4         | 59.2 $\pm$ 25.8         | 21.2%           | .0001        |

Anatomical knowledge loss in first- and fourth-year nursing students. The data above indicates the mean score and standard deviations of all the organ systems assessed for knowledge loss in the first year and then compared for overall loss on the same organ systems in the fourth year nursing;  $P < 0.001$ .

## Discussion

- The significant differences between knowledge loss in the fourth year largely depended upon the individual organ system being assessed.
- These differences in knowledge loss may be attributed to the level of difficulty of the questions, the time period between time learned and time tested, or students' perceived usefulness of the information.
- Future studies could investigate the variables that impact specific system knowledge loss and the interventions that might improve those retention levels.
- Overall, the results of this study are consistent with other studies of medical and nursing students that reported an average 41% and 19.% loss of anatomical knowledge within four years (Diaz-Mancha et al., 2016).

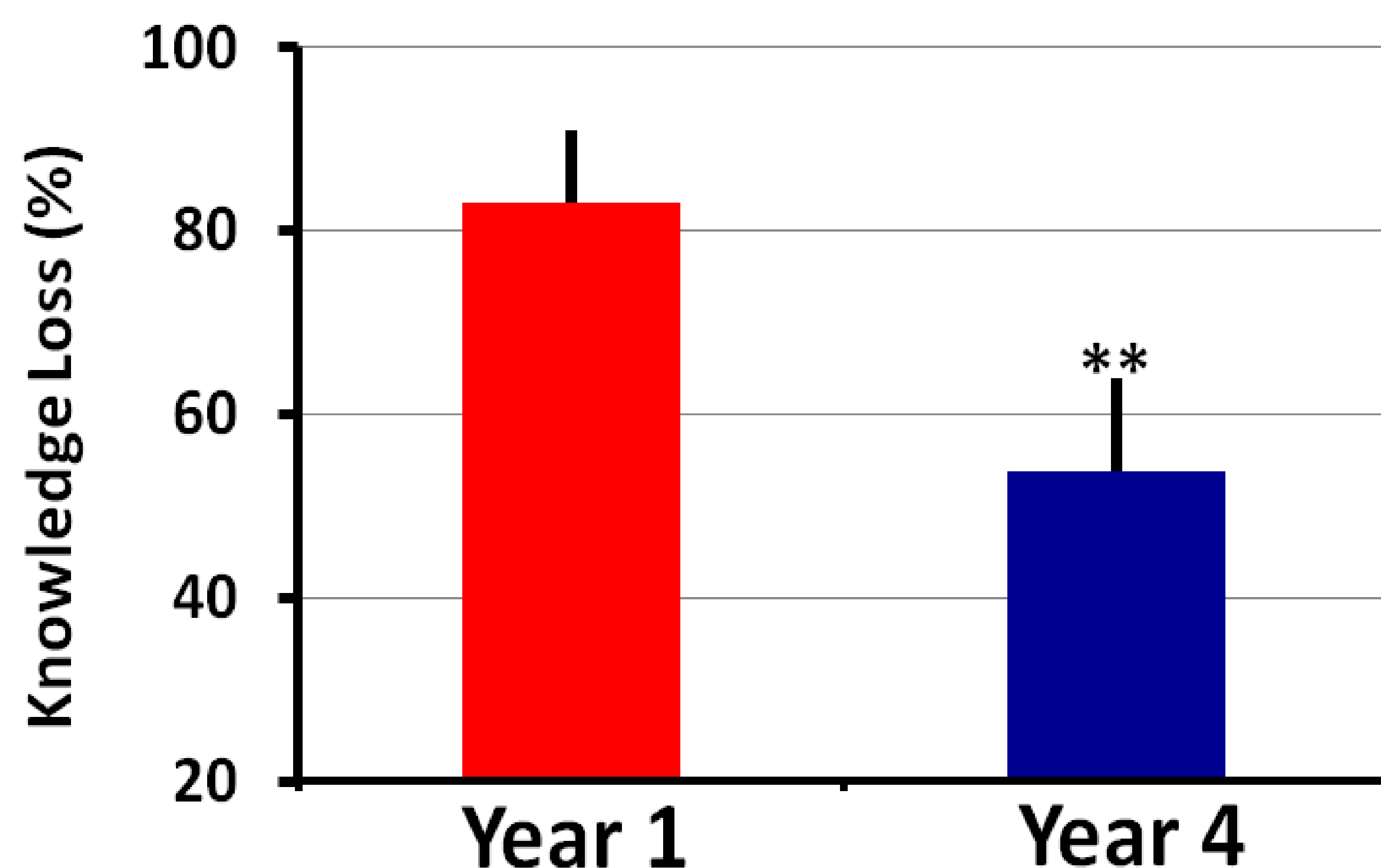
## Conclusion

- The retention of anatomical knowledge varied by body system, and the overall loss of 29.6% is consistent with results reported in studies of medical and allied health professional students.
- While the loss is consistent with other disciplines, it does raise the concern of how much anatomical knowledge is retained by students throughout their program and by registered nurses once they enter practice.
- Studies are currently underway to evaluate a robust interventional strategies to improve knowledge retention in nursing students.
- Future studies could involve the development and evaluation of teaching strategies to increase the level of anatomical knowledge retention in health disciplines.

## References

- Díaz-Mancha JA, Castillo-López JM, Munuera-Martinez PV, Fernández-Seguín LM, Polo-Padillo J, Heredia-Rizo AM. 2016. A comparison of fourth year student health sciences student's knowledge of gross lower and upper limb anatomy: A cross-sectional study. *J Man Physiol Ther* 39:450-457.
- McVicar A, Andrew S, Kemble R. 2015. The 'bioscience problem' for nursing students: An integrative review of published evaluations of Year 1 bioscience, and proposed directions for curriculum development. *Nur Educ Today* 35(3):500-509.
- Narnaware Y, Neumeier M. 2020. Second-year nursing students' retention of gross anatomical knowledge. *Anat Sci Educ* 13:230-236.
- Narnaware, Y. 2021. Never Heard That Before! Bioscience Knowledge Retention in Undergraduate Nursing Education. *Educator* 25 (2):77-80.

**Figure 1. The Summary of Overall Anatomical Knowledge Loss**



Year 1 and Year 4 bars represent the overall mean scores from all organ systems converted into percent knowledge. There is a significant decrease in knowledge between years 1 and 4 ( $P < 0.001$ ).