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Comparison of dental flosses – an investigation of subjective preference and mechanical properties

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ABSTRACT

Objective: To investigate the properties (tensile strength, roughness, abrasiveness) of different dental flosses and how these properties relate to subjective preference for floss by users.

Materials and method: Four flosses of differing compositions were selected (polytetrafluoroethylene (PTFE), nylon, silk, and ultra-high-molecular-weight polyethylene (UHMWPE)). Tensile strength (TS) was measured utilising a universal testing machine (total $n = 40$). Surface roughness (Ra) was measured on 3D reconstructed models of scanning electron microscope and abrasiveness was measured through block-on-ring tests against human enamel. Subjective preference for floss was measured by asking a sample of 16 individuals to use each floss for an 8-day period using a split-mouth design.

Results: The highest TS was found in UHMWPE floss (194.18±24.61 MPa) while the lowest TS was found in PTFE floss (11.78±0.77 MPa). Silk floss had the highest Ra (0.304±0.025 µm) while PTFE floss had the lowest (0.048±0.003 µm). In-vitro abrasion testing of the flosses identified no significant differences between the flosses in causing wear on tooth enamel. Subjective ratings of flosses indicated PTFE floss to be most preferred and nylon floss to be least preferred.

Conclusion: There was a difference in subjective preference between dental flosses composed of different materials. The PTFE floss was the overall most preferred while the nylon floss was the least preferred. There was also an association between the mechanical properties and preference for their usage, with PTFE floss being the most preferred but having the lowest surface roughness and tensile strength.

Clinical Relevance: This study compared a wide range of mechanical properties and subject preferences of commercially available dental floss. The results of this study can provide guidance for the recommendation of dental floss for oral hygiene routines.

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KEYWORDS
Dental floss; tensile strength; abrasiveness; surface roughness; preference

1. Introduction

Dental floss is defined as the multiple filaments of silk or synthetic fibres that are gathered into thread, designed for the removal of plaque or debris from the proximal surfaces of dentition [1], and is perhaps the second most common dental cleaning tool after the toothbrush. Dental floss is ubiquitous in various fields of dentistry; for example, it is an adjunct often employed in evaluating dental restorations or in professional dental prophylaxis [2].

An array of dental flosses is available on the market. These may be made from polytetrafluoroethylene (PTFE, also known as Teflon), nylon, ultra-high-molecular-weight polyethylene (UHMWPE), or silk. These may also include waxed and unwaxed versions. Many people have health concerns regarding modern synthetic materials and this has led to the rise of eco-friendly flosses—these are often made of silk, with or without a coating of candelilla wax. While an abundance of dental floss choices is available, there currently is a lack of scientific evidence for the recommendation.

Very little scientific literature has explicitly investigated or described the ideal properties of dental floss. Some of the few were authored by Charles C. Bass [3,4], who is credited for the invention of various preventive oral self-care practices [5]. In these papers, Bass suggests the usage of unwaxed nylon floss over the use of contemporary alternatives, such as silk floss, and waxed floss [3]. Reasons for this recommendation include the superior tensile strength of

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nylon, and the wax residue left by waxed floss, which may promote gingivitis [3]. However, most reasons given by Bass [3,4] were based on qualitative observations, rather than comparisons of quantitative evidence. Furthermore, technological advancements and contemporary scientific studies have invalidated many of the reasons for this recommendation.

With the availability of PTFE and UHMWPE materials, dental floss material is no longer limited to nylon and silk; however, literature recommending the usage of one over the other is limited. More recent studies regarding dental flosses have stated the importance of patient preference when recommending specific types of floss [6–8]. However, few studies have directly investigated whether patient preference for different flosses is associated with the physical properties of the floss.

The mechanical properties of dental floss can affect its ease of use. Supanitayonon et al. (2017) and Stavrakis et al. (2022) tested the mechanical properties of ultimate tensile strength and percentage of elongation (%E) between different types of dental flosses. Their findings indicated that a wax coating does not affect floss tensile strength, but that it did affect %E [9,10]. Further studies are necessary to investigate how the inclusion of wax may affect other mechanical properties of floss.

Few studies have investigated the correlation between the mechanical properties of floss and patients' preference for their usage [8]. Hanes et al. (1992) found no correlation between the tensile strength of dental floss and subjective approval. While other studies, such as Dörfer et al. (2001), have suggested the link between the mechanical properties of floss and patients' adherence to flossing, those studies did not explicitly examine the correlation [7].

While there have been substantial efforts to characterise the efficacy of different dental flosses in cleaning teeth, few studies have investigated the determinants of preference. There is also a lack of literature concerning the mechanical properties of dental floss; studies that do investigate their mechanical properties often only investigate one property. Moreover, there are an extremely limited number of studies regarding dental floss made from ultra-high molecular weight polyethene due to their recent invention.

Therefore, the aim of this research was to build the evidence base for recommending which kind of dental floss a person might prefer to use. The objectives of this research were (1) to investigate the subjective preferences towards the different dental flosses, and (2) To investigate the mechanical properties of different dental flosses (tensile strength, surface roughness, abrasiveness). Hypotheses were (1) there is a significant difference in subjective preferences towards different dental flosses composed of different materials, and (2) there is a significant difference in mechanical properties (tensile strength, surface roughness, abrasiveness) between dental flosses composed of different materials.

2. Materials and methods

This study used mixed methods: Part One was a product acceptability study to evaluate subjective preferences of four dental flosses while Part Two was an investigation of mechanical properties of the same flosses.

2.1. Ethics and consent to participate

Ethical approval was obtained from the University of Otago Human Ethics Committee (reference code H22/039). Participants gave written informed consent before participating. Four different dental flosses available were selected for study based on their compositions (Table 1).

2.2. Part 1. Evaluation of subjective preferences

A convenience sample of tertiary students ($n = 16$) was recruited, using the selection criteria shown in Table 2. Volunteers were informed of the selection criteria *via* email; those who indicated their eligibility were invited for screening for signs of obvious dental decay by the investigators. The screening process did not involve periodontal probing or the taking of dental radiographs.

Each participant was provided with 8 pre-packaged, numbered envelopes (Day 1 to Day 8). Each envelope contained 4 strands of dental floss within 4 small zip-lock bags (labelled E1 to E4). Participants were blinded to the type of floss being used, and these changed each day. Participants used these strands of dental floss following the instructions listed in Table 3.

Participants then answered questions to provide their current understanding of the floss available and their preference after using each type. The questionnaire was provided to participants electronically to answer every day.

Guttman scale questions:

1. *This floss was pleasant to grip while flossing.*
2. *This floss was comfortable to pull through between my teeth.*

Table 1. Selected floss to be included in the study.

Group	Product name (Brand)	Material	Wax
1	Total (Colgate)	Polytetrafluoroethylene (PTFE) fibre	Micro-crystalline
2	Essential (Oral-B)	Nylon	Micro-crystalline
3	Gorilla (Piksters)	UHMWPE	Information not available
4	Eco Floss (Do Gooder)	100% silk	Natural candelilla wax

Table 2. Inclusion and exclusion criteria.

Inclusion criteria
1. Good general health
2. Signed informed consent obtained
3. Over the age of 18
4. No visible gaps between teeth
Exclusion criteria
1. Evidence of inadequate oral hygiene
2. Gross dental caries
3. Severe periodontal diseases requiring professional therapy
4. Undergoing orthodontic treatment, or using orthodontic appliances
5. Physical disabilities limiting the effective dental flossing
6. A medical history of bleeding disorders, diabetes mellitus, or heart pacemaker
7. Medical conditions requiring antibiotic prophylaxis prior to dental treatment

Table 3. Instructions for participants for the preference study.

Participating day	Instructions
Day 1	Eight envelopes labelled Day 1 to Day 8 containing 4 packets of dental floss (packets E1 to E4) is provided to participants.
Day 2	Brush teeth twice a day (morning and night) using a toothbrush and dentifrice.
Day 3	Use floss from the envelope which corresponds to the day of the study. For example, use the floss from envelope Day 1 for day 1 of the study.
Day 4	Floss teeth in each quadrant using floss from the corresponding packet. For example, floss teeth in quadrant 1 (upper right) with the floss from packet E1.
Day 5	Floss all teeth in all quadrants using floss immediately prior to brushing teeth.
Day 6	Complete the questionnaire provided after flossing.
Day 7	Repeat steps 2 to 6 every day for the 8-day duration
Day 8	Do not use any other interdental cleaning aids other than the floss provided for the 8-day duration.

3. *This floss tends to shred or fray during use.*
4. *This floss tends to snap when I am using it.*

Ranking questions:

1. *Which floss (between the flosses E1 to E4) did you feel cleans better between teeth?*
2. *Which floss (between the flosses E1 to E4) caused the most pain or sensitivity while using?*
3. *Which floss (between the flosses E1 to E4) would you most likely continue to use?*

On each of the 8 days, participants completed a brief questionnaire that included a combination of Guttman scale questions and ranking questions. For the Guttman scale questions, participants rated each of the statements on a scale of 1 to 5 with 1 being "strongly disagree" and 5 being "strongly agree". This was done for all the flosses separately. Ranking questions involved participants arranging items (the flosses) into order from top to bottom. The item at the top of the list was the most preferred, while the item at the bottom is the least preferred. For example, when answering the first ranking question on day 1, the number placed at the top of the list by the participant was the number of the zip-lock bag (E1 to E4) which contained the floss that the participant believed cleaned the best between teeth on that day. Statistical analysis was conducted once the results of the questionnaires were collected. This was done primarily through cross-tabulations with Chi-squared test for the statistical significance of differences in categorical variables. Lastly, an appropriate statistical analysis was chosen depending on the outcome of the rating data (parametric or not).

To analyse the difference in ratings between flossing with the same floss in maxillary and mandibular teeth and the difference in ratings between flossing with the same floss on different days, results of the rating questions were modelled using a multilevel mixed-effects ordered logistic regression.

2.3. Part 2. Investigation of mechanical properties

A sample size calculation was performed based on pilot testing using the G * Power software v3.0.10 (Heinrich-Heine-Universität Düsseldorf). The required sample size was calculated for $\alpha = 0.05$ and a power of 0.95 (1-β err prob), assuming a normal distribution. The calculation showed that 10 specimens for tensile and surface roughness testing and 5 for abrasion testing were required for the study.

2.3.1. Tensile strength testing

Each floss type was cut into 100 cm long strands ($n = 10$/group) and the two ends were tied and secured by the vertical clamps (Figure 1). The length of floss between the clamps was standardised to 10 cm. Each specimen was subjected to tensile testing by using a universal testing machine (Instron 3369; Intron, USA) with a 500 N load cell at the crosshead speed of 20 mm/min. The load at failure (N) and displacement until failure (mm) were recorded for each specimen. The tensile strength was calculated using the formula:

$$\mathit{Tensile\ Strength}\ (MPa) = \frac{\mathit{Maximum\ load\ at\ failure}\ (N)}{\mathit{Cross\ sectional\ area\ of\ floss}\ (mm^2)*}$$

* Cross-sectional area (mm^2) was calculated based on the measurements obtained by an optical microscope (Nikon, Japan; with the magnification of × 2 to × 10).

2.3.2. Surface roughness testing

Surface roughness was measured on a 3D reconstructed model of scanning electron microscope (SEM) images using the *MountainsMap* surface analysis and metrology software (Figure 1). Each floss type was cut into 10 mm long strands and prepared for SEM. Prepared specimens were mounted on aluminium stubs, using double-sided carbon tape. They were coated with approximately 10 nm of carbon in a Peltier-cooled high-resolution sputter coater (Emitech K575X; EM Technologies Ltd) fitted with a carbon coater (Emitech 250X; EM Technologies Ltd). Analysis was conducted by field emission SEM (JSM-6700F; JEOL). Each floss type had 5 pairs of SEM images taken for 10 measurements of surface roughness ($n = 50$). Each pair of images:

1. were images of the same section of the floss
2. had the same magnification (between ×100 to ×250)
3. had a difference of tilt angle of 10 degrees along Y-axis only.

A pair of SEM images was used for reconstruction. The surface roughness of each 3D reconstructed model was measured through the *MountainsMap* software. The amplitude parameter Ra, relating to the arithmetic mean between the peaks and a valley of the surface was used.

2.3.3. Abrasion (wear) testing

Floss was wrapped around a 3D-printed ring-shaped specimen which was subjected to abrasion/wear testing against human enamel (block-on-ring tests) in dry condition. The test was carried out under 4 N to simulate forces during flossing [7] at a rotation speed of 60 rpm for 200 cycles using a universal wear testing machine (NeoPlus UFW200). Floss was wrapped around the ring-shaped specimen to fully cover the surface area of the specimen. The vertical wear loss (mm) was be calculated and statistically analysed (Figure 1).

3. Results

3.1. Part 1. Product acceptability study: Gutman questions

The results of each floss acceptability rating are presented in Figure 2 (a–d). Each bar graph lists the floss types and displays the percentage of each response. For example, in Figure 2(a), around 90% of the responses for the statement "this floss was pleasant to grip while flossing" were either "strongly agree" or "agree" for PTFE floss.

Figure 2 shows that the majority of responses for PTFE, nylon, and UHMWPE floss agreed or strongly agreed that those floss are pleasant to grip while flossing. Responses for silk floss showed that there was roughly a 50/50 split between those who agreed/strongly agreed and those that disagreed/strongly disagreed.

A large majority of responses either strongly agreed or agreed that PTFE and nylon floss were comfortable to pull through teeth. There was roughly a 60/40 split between those who agreed/strongly agreed and those who disagreed/strongly disagreed that UHMWPE floss was comfortable to pull through teeth. In contrast, there was a 40/60 between those who agreed/strongly agreed and those that disagreed/strongly disagreed that silk floss was comfortable to pull through teeth.

In Figure 2(c), a large majority of responses disagreed/strongly disagreed that all types of flosses frayed or shredded during use. Similar to Figure 2(C and D) displays that a large majority of responses strongly disagreed that all types of flosses tended to snap during usage.

A series of multi-level multinomial logistic regression models of the rating questions are shown in Table 4. After controlling for days of flossing and arch (maxillary vs mandibular) PTFE floss had significantly higher comfort and grip than nylon floss, while silk and UHMWPE had worse comfort and silk had lower (worse) grip. PTFE had lower (better) ratings for fraying than Nylon while silk and UHMWPE had higher ratings for fray. Silk had greater ratings for snap than nylon but the other two floss types did not differ significantly.

The results of each ranking question from the product acceptability study are presented in Table 4. Each lists the floss type and the frequency in which each floss type was ranked 1 to 4. For example, silk floss was ranked first 23 times for the question:

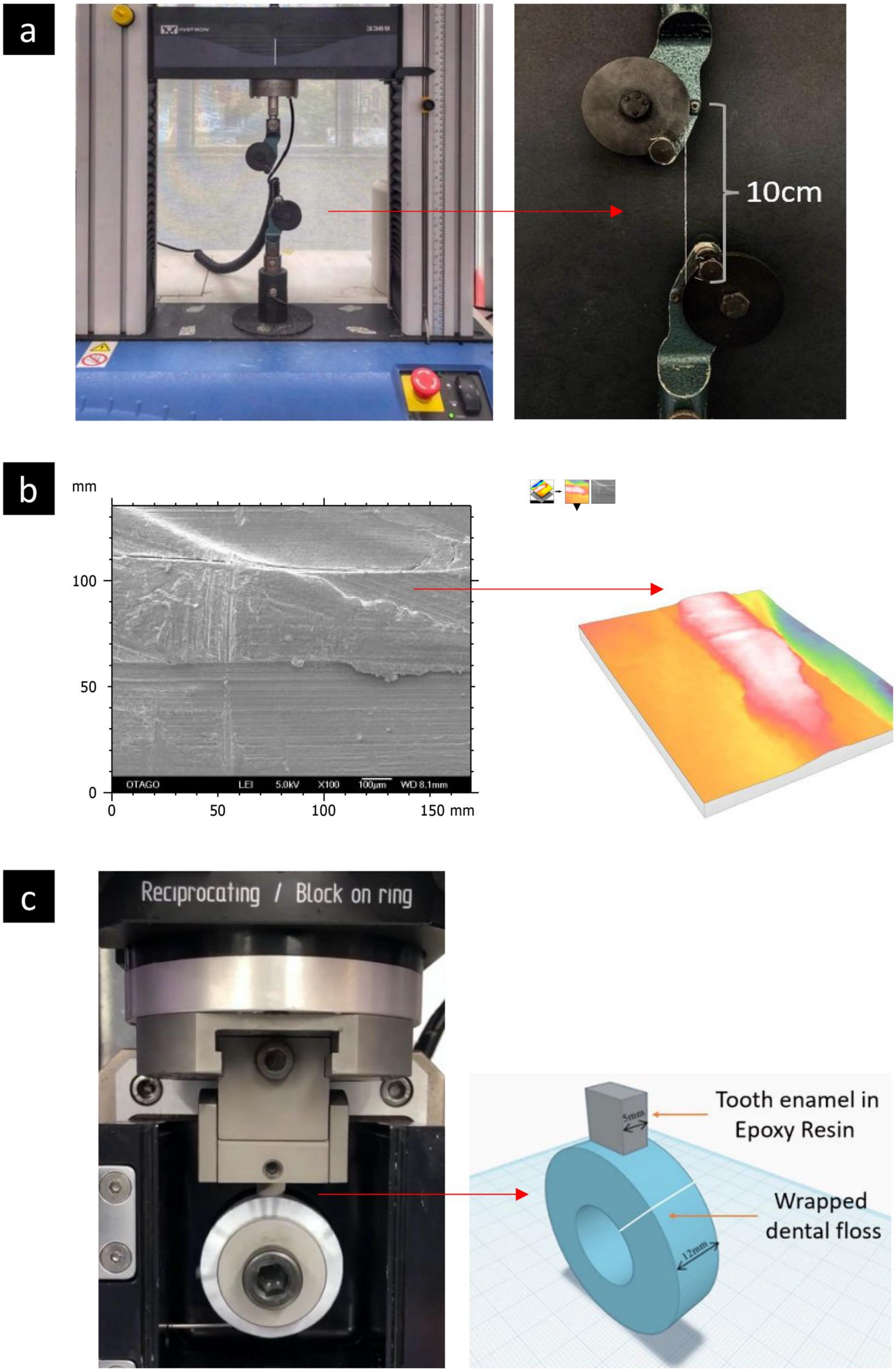

Figure 1. Images of mechanical testing set ups for (a) tensile strength; (b) surface roughness c) wear loss.

"Which floss cleaned the best between teeth?" This accounted for 19.3% of the total responses given for silk floss for that question.

Table 5 shows the mean rank of each floss for each question. The results which are depicted in Table 5 include:

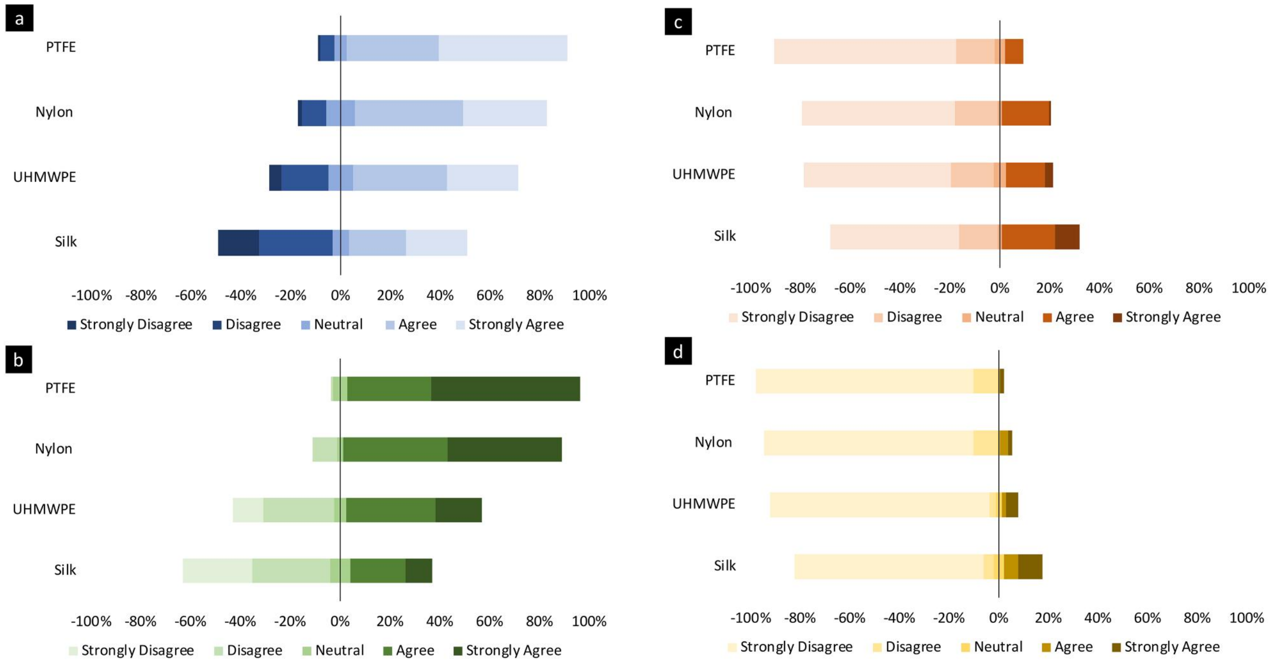

Figure 2. Graphs showing the ratings for the statement; (a) this floss was pleasant to grip while flossing; (b) this floss was comfortable to pull through between teeth; (c) this floss tends to shred or fray during use; (d) this floss tends to snap when I am using it.

Table 4. Ordered logistic regression model of rating score by floss type.

	Coefficient	95% conf. interval	
Comfort			
Floss type			
Nylon (reference)	0		
PTFE	0.603	0.104	1.102
Silk	−2.683	−3.212	−2.155
UHMWPE	−1.690	−2.190	−1.189
Mx vs Md	−.157	−.499	0.185
Grip			
Floss type			
Nylon (reference)	0		
PTFE	0.947	0.426	1.467
Silk	−1.577	−2.095	−1.060
UHMWPE	−0.464	−0.956	0.028
Mx vs Md	−.167	−.522	0.188
Snap			
Floss type			
Nylon (reference)	0		
PTFE	−0.371	−1.22	0.481
Silk	1.138	0.351	1.925
UHMWPE	−0.123	−0.987	0.741
Mx vs Md	0.388	−.198	0.973
Fray			
Floss type			
Nylon (reference)	0		
PTFE	−1.033	−1.644	−0.421
Silk	0.961	0.370	1.552
UHMWPE	0.053	0.529	0.635
Mx vs Md	−.013	−.429	0.402

1. Participants believed PTFE floss cleaned the best between teeth (mean rank 2.00) while silk floss cleaned the worst (mean rank 2.55).
2. Silk floss caused the most pain during flossing (mean rank 2.09) while PTFE floss caused the least pain (mean rank 2.59).

Table 5. Mean rank of each floss for each corresponding question.

	Floss type			
Ranking questions	Silk	UHMWPE	Nylon	PTFE
Which cleaned the best?	2.55	2.21	2.53	2.00
Which caused the most pain?	2.09	2.27	2.51	2.59
Which would you likely continue using?	2.46	2.24	2.5	2.02

3. Out of the four flosses in the study, participants would most likely continue using PTFE floss (mean rank 2.02) and would least likely continue using nylon floss (mean rank 2.50). Results from this ranking question indicate the overall preference of participants towards the flosses studied.

3.2. Part 2. Mechanical properties

The mean and standard deviation of tensile strength, surface roughness, and wear loss for each floss type are presented in Figure 3, data is expressed as mean ± SD. Two columns joined by a bracket indicate that a significant difference was observed between the two types of dental floss, where $^{*}p < 0.05$ and $^{**}p < 0.005$.

The calculation of tensile strength required the measurement of the width of floss (mm) under an optical microscope. These measurements were 0.5 mm for nylon floss, 0.45 mm for silk floss, 1.55 mm for PTFE floss, and 0.44 mm for UHMWPE floss. In summary, the highest tensile strength was found in

UHMWPE floss (194.18 MPa ± 24.61) while the lowest tensile strength was found in PTFE floss (11.78 MPa ± 0.77). Excluding the comparison between nylon floss and silk floss, the comparison of tensile strength between other flosses had statistically significant differences ($p < 0.05$). Silk floss had the highest surface roughness (Ra) at 0.3035 μm ± 0.0254 while PTFE floss had the lowest (0.0478 μm ± 0.0034). Excluding the comparison of Ra between UHMWPE floss and nylon floss, all other comparisons of Ra yielded significant results ($p < 0.05$). No significant differences in tooth wear were observed in abrasion testing among the flosses studied.

An examination of the load vs. displacement curves for tensile testing (Figure 3(a)) is suggestive of possible mechanisms for failure. The load vs. displacement curves of the silk floss and the nylon floss (Figure 3(a)) follow similar trends; there is a steady increase in loading force and displacement before sudden failure at maximum loading force. Certain specimens, like silk floss specimen 1 in Figure 3(a), follow an atypical trend where there are multiple, sharp drops in loading force indicative of multiple fractures. Once maximum load has been reached in the PTFE floss, it continues to display substantial displacement until subsequent fracture.

SEM images taken of the specimens before and after tensile testing further supplement this analysis (Figure 4) and images allow characterisation of their structures. The nylon floss, silk floss and UHMWPE share a similar structure in that they are composed of many filaments wound into thread. Nonetheless, there are still differences which exist between their thread-like structures. At 25 x magnification, the filaments which make up the nylon floss appear almost parallel to one another, as they have similar orientations. In contrast, the filaments of the silk floss and the UHMWPE floss have more divergent orientations. The filaments of the UHMWPE floss are tightly wound, with minimal space in the thread-like structure while the silk floss is more loosely wound, with observable gaps in its thread-like structure at 25× magnification. The PTFE floss has a structure dissimilar to the others. Instead of a thread-like structure, it has a broad, sheet-like structure. Filaments are not wound together but rather appear to be layered on top of one another to form this sheet-like structure.

4. Discussion

This study contributed to the evidence base for recommending which kind of dental floss to use by investigating differences between subjective preference and mechanical properties of four different types of commercially available dental floss. Research hypothesis 1 was accepted as there was a significant difference in subjective preference between different flosses composed of different materials. Research hypothesis 2 was partially rejected as mechanical testing of the dental flosses resulted in significant differences in tensile strength and surface roughness (Ra) but non-significant differences in abrasiveness between the four dental flosses.

Part One of this study found the PTFE floss to be most preferred, having the lowest mean rank for the question "Which floss would you most likely continue using." This outcome was consistent with the finding that participants perceived the PTFE floss to clean better and cause less pain than the other floss types. The PTFE floss scored the most favourably in all rating questions. In contrast, participants perceived that the silk floss cleaned the worst between teeth and caused the most pain. The silk floss also scored the most unfavourably in all rating questions. However, the silk floss was not the overall least preferred floss; the nylon floss was, with a mean rank of 2.50. This discrepancy is suggestive that there are more determinants of overall preference than the ones investigated in this study. One such determinant which may have been overlooked was the flavour of the floss, a factor found to be important by other investigators [6].

Part Two of this study found UHMWPE floss to have the highest tensile strength and surface roughness (Ra) between the flosses studied while the PTFE floss displayed the lowest tensile strength and surface roughness. The UHMWPE floss also possessed the highest abrasiveness but results from abrasiveness testing were non-significant.

The high tensile strength of the UHMWPE floss found was within expectations; UHMWPE is known to have high hardness and durability [10] when compared to other polymers such as nylon and PTFE. However, UHMWPE is also a material known for its low coefficient of friction [11] which is not reflected in its relatively high surface roughness found in this study. This result can be accounted for by its structure as shown by the SEM images. The measure of surface roughness used in this study (Ra) relates to the average surface heights and depths across the floss. While a sheet of UHMWPE may result in low surface roughness, the UHMWPE floss is composed of multiple filaments of UHMWPE wound into thread. The effect of structure on surface roughness is also implicated when looking at the low surface roughness of the PTFE floss. The PTFE floss has a singular,

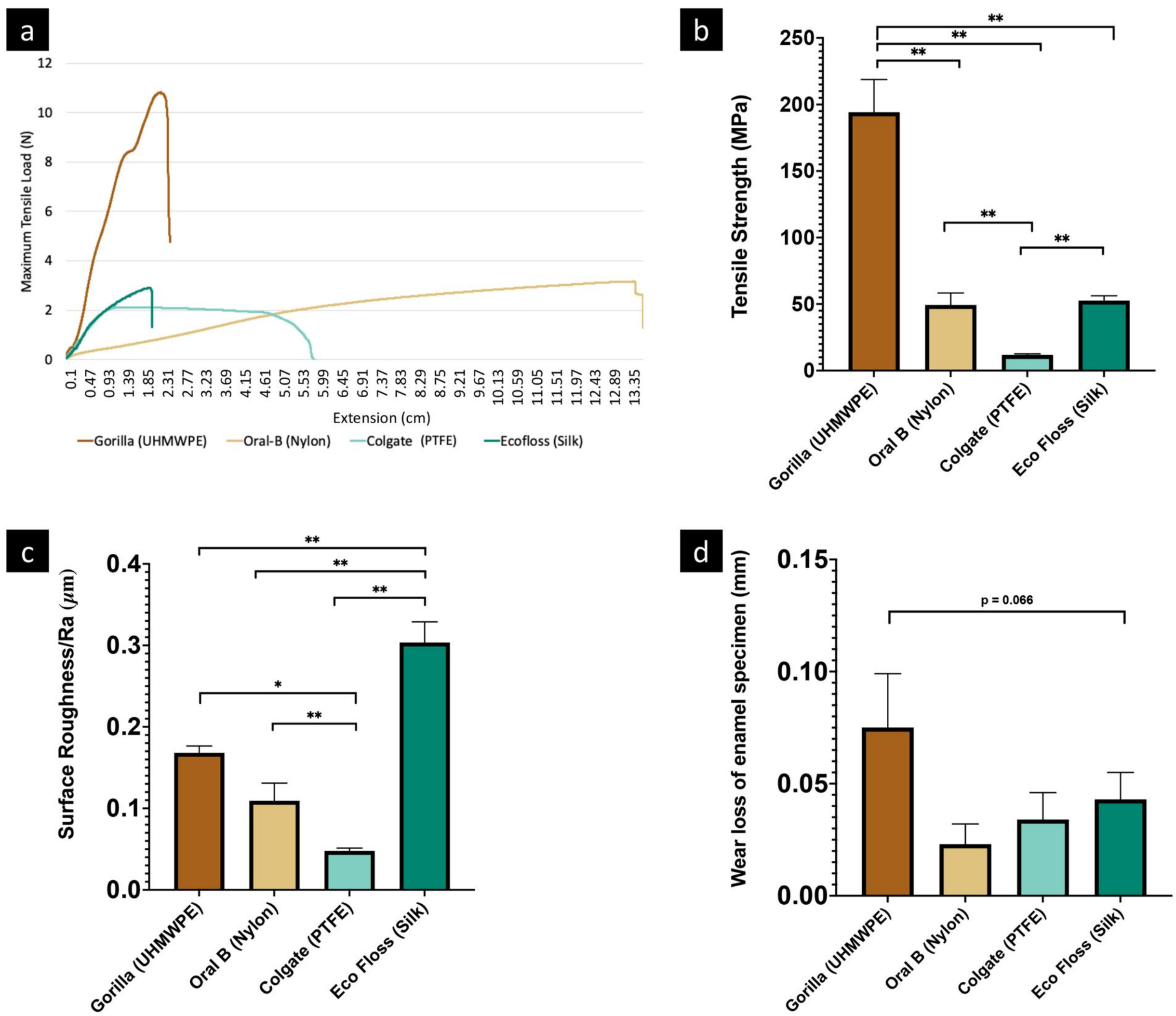

Figure 3. Images showing (a) load vs displacement curves for each floss; bar graphs showing b) the mean tensile strength; (c) surface roughness; (d) abrasiveness.

broad, sheet-like structure, unlike the thread-like structure of the three other flosses examined.

When viewing the results of **Part One** and **Part Two** together, correlations between certain mechanical properties and overall preference is weak. This is most exemplified when looking at the difference in overall preference for the PTFE floss and the nylon floss. In general, the PTFE floss and the nylon floss have relatively similar mechanical properties. The PTFE floss had the lowest tensile strength (11.78 MPa ± 0.77) and surface roughness (0.048 μm± 0.003) while the nylon floss had the second lowest tensile strength (49.28 MPa ± 9.07) and surface roughness (0.10 μm ± 0.022) between the 4 flosses studied. However, the PTFE floss was the overall most preferred floss while the nylon floss was the least.

Results were suggestive of correlations between certain determinants of preference and mechanical properties. Expectedly, the surface roughness of floss was correlated to participants' perception of comfort during flossing; PTFE floss was rated the most comfortable, nylon was rated second, UHMWPE as third, and silk floss as the least comfortable. There was a surprising lack of association between tensile strength and the tendency for the flosses to snap during usage. UHMWPE floss, which had with a tensile strength multiple times greater than the tensile strength of nylon floss, had a similar tendency to snap when participants flossed with them. A possible reason for this is the presence of sharp or rough overhangs at certain interproximal contacts which may sever dental flosses when flossing.

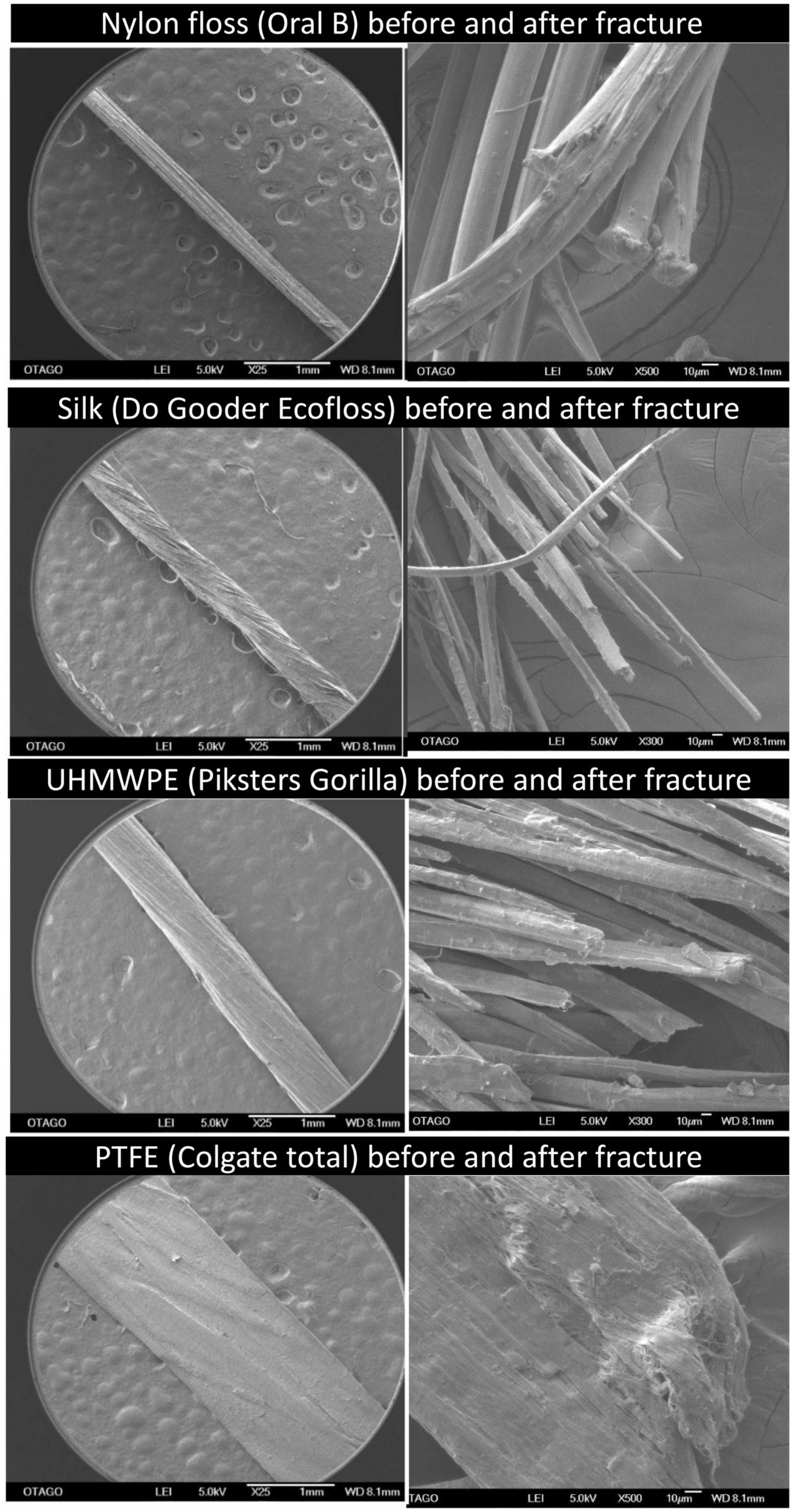

Figure 4. SEM images of four flosses studies before and after tensile fracture.

With the results of this study, the following are some recommendations that can be considered when choosing which floss to use for homecare:

- For people who experience discomfort when flossing due to having sensitive gingiva, the usage of a floss with minimal surface roughness such as the PTFE floss may be recommended.

- Individuals who struggle to fit floss between tight interproximal contacts should consider the structure of the floss they are using. They may benefit from using flosses with a broad, sheet-like structure such as the PTFE floss rather than flosses with thick, thread-like structures.
- While the eco-friendly reasons for using silk floss are determinants of preference, its disadvantages should also be considered when choosing which floss to use.

Certain limitations exist within both the product acceptability study and the testing of mechanical properties. Since this was the first research to evaluate the subject preference in correlation to the mechanical properties of floss, future studies with an increased size per group or type of floss would be beneficial. The participants recruited were all in good oral health; participants had few restorations with overhangs, all already had a habit of flossing, and none had visible gaps between teeth. The participants were also limited to younger adults. A different floss preference profile might be observed in a different age group (e.g. among older people). These factors may contribute to limiting of the generalisability of the results. While limitations do exist, this was the first study of which we are aware that considered a wide range of mechanical properties and patient preferences of several different dental flosses. This study still provides a reference point for future research and follow-up studies.

The majority of questions in the product acceptability study were based on likely determinants of preference. An assumption made when designing the questionnaire was that qualities relating to comfort during usage were major determinants. As such, many of the questions of the questionnaire were related to aspects of comfort during usage (e.g. pain when flossing, comfort when gripping the floss, and comfort when flossing between teeth). However, questionnaire results displayed a lack of correlation between aspects of comfort, and overall preference for usage between the flosses studied. Future studies to investigate preference between dental flosses may choose to use a greater variety of questions. Factors such as the appearance of the floss and the flavour of the floss should be taken into consideration. If future studies choose to focus on which floss participants would most likely buy (rather than use), price of floss should also be accounted for as a determinant of preference.

Further efforts to characterise abrasiveness would be valuable because of the property's clinical implications. The characterisation of abrasiveness of dental flosses could provide a reason for recommendation similar to how relative dentine abrasivity (RDA) contributes to the recommendation of dentifrices [12]. Future studies that investigate the abrasiveness of flosses should consider testing against dentine specimens instead of enamel specimens. As dentine is softer than enamel [13], results from abrasiveness testing may have greater and statistically significant differences in wear loss. Lastly, abrasiveness may be linked to how much floss materials and coatings chip away. Studies have found an association between the usage of polytetrafluoroethylene (PTFE) coated dental floss and higher blood serum levels for polyfluoroalkyl substances (PFASs), which are possible carcinogens linked to kidney and testicular cancer [14]. However, these studies do not examine the possible modes in which the PFASs enter the blood serum, therefore the abrasively and loss of floss materials over time can be investigated in future studies.

5. Conclusion

In consideration of the results and limitations of the study, the following may be concluded:

- There is a difference in tensile strength and surface roughness for dental flosses composed of different materials. UHMWPE floss displayed the highest tensile strength while PTFE floss displayed the lowest. Silk floss had the highest surface roughness (Ra) while PTFE floss had the lowest.
- There was a difference in subjective preference between dental flosses composed of different materials. The PTFE floss was the overall most preferred while the nylon floss was the least preferred.
- There was an association between the mechanical properties and preference for their usage, with PTFE floss being most preferred but having the lowest surface roughness and tensile strength and factors which determine preference for dental floss are not limited to comfort during usage.

Author contribution

Conceptualization – JMB, JJEC; Data curation - ZH, JMB, JJEC; Formal analysis ZH, JMB, JJEC; Investigation- ZH, JMB, JJEC; Methodology- ZH, JMB, JJEC; Project administration - JJEC; Writing - original draft - ZH, JMB, JJEC; Writing - review & editing - ZH, JMB, JJEC

Disclosure statement

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Data availability statement

Data will be available upon request.

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