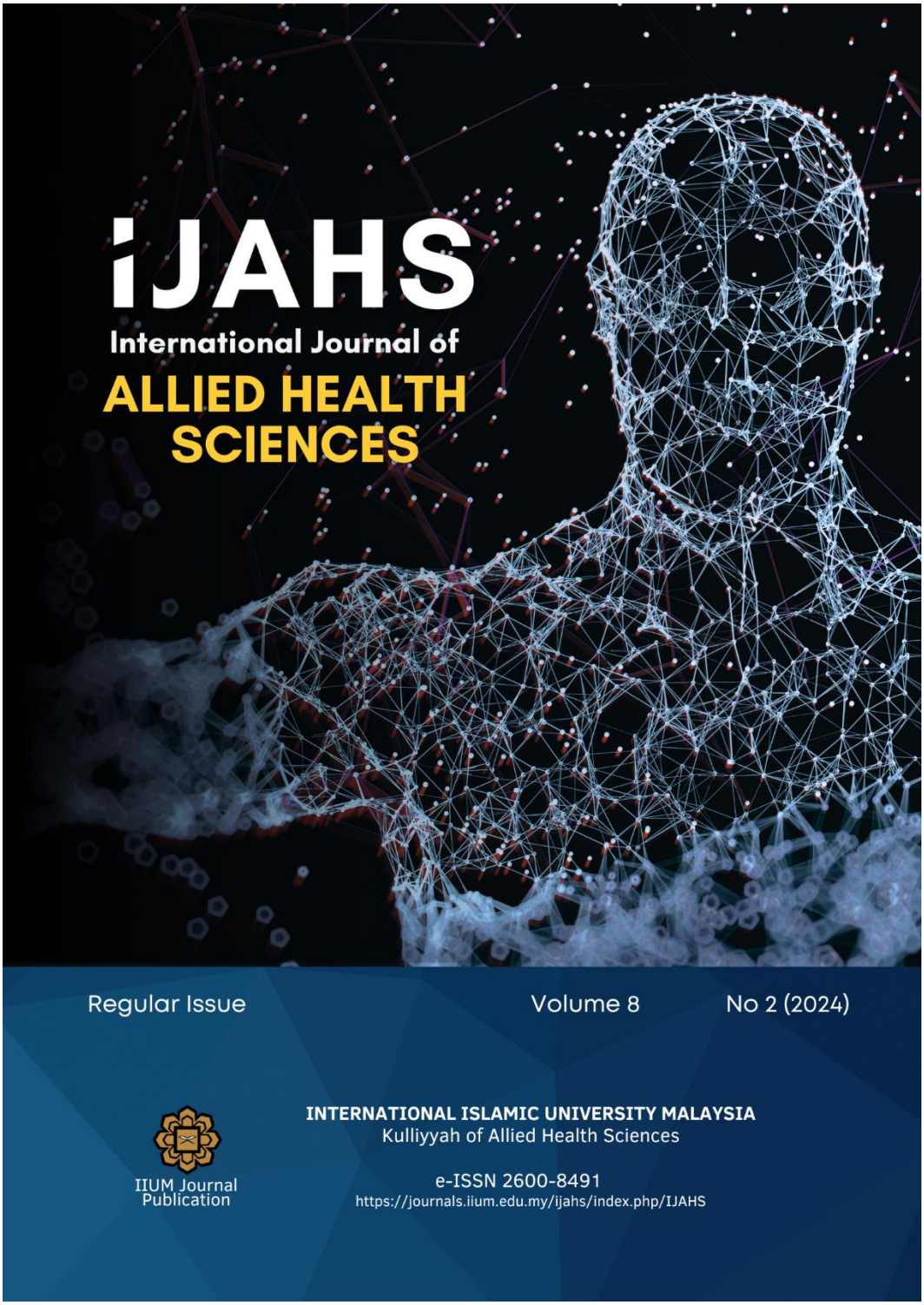
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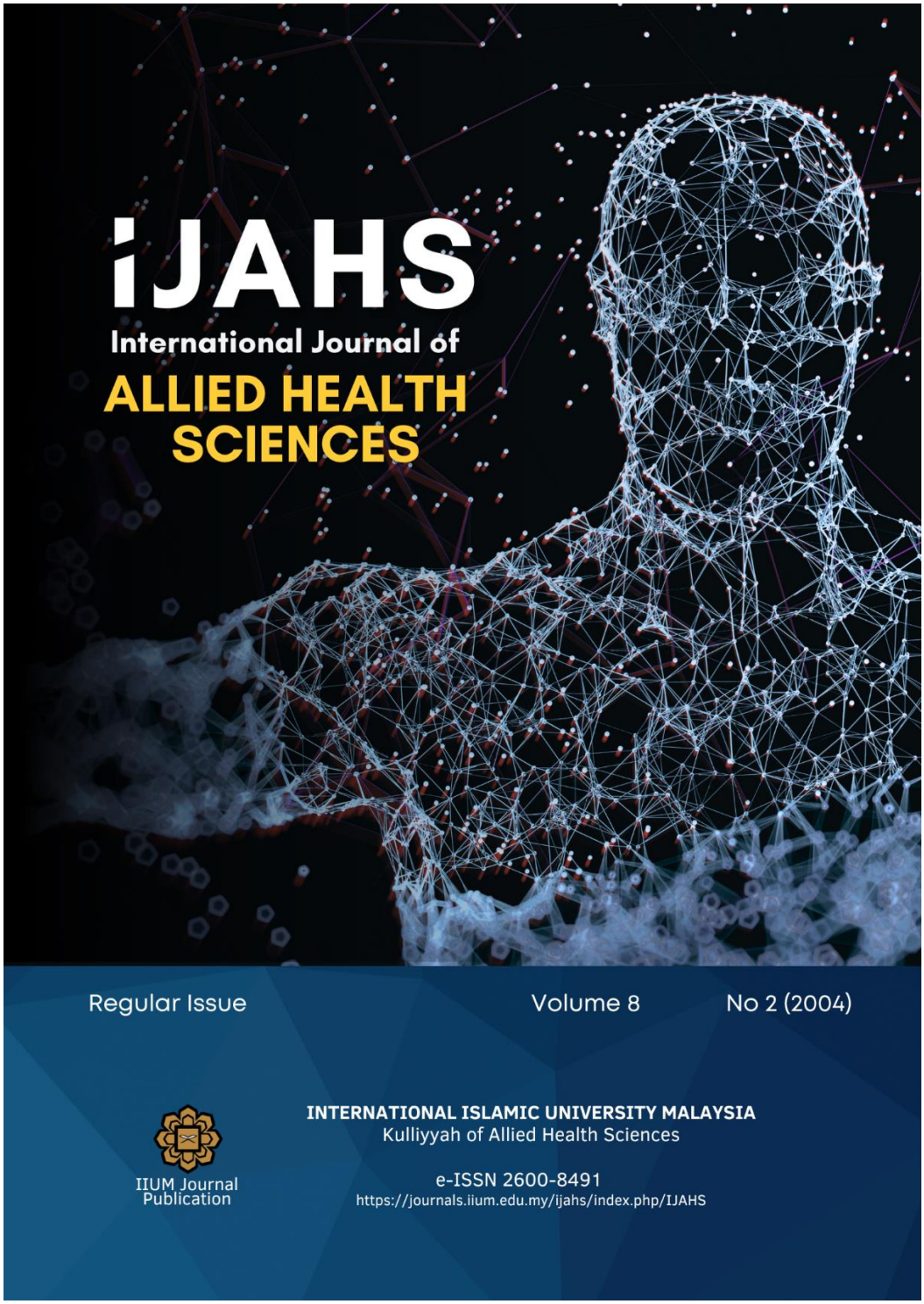
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Four Recurrent Miscarriages – Is It a Case of Antiphospholipid Syndrome?

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Abstract:

Introduction: Antiphospholipid syndrome (APLS) is usually clinically suspected in antenatal women presented with recurrent miscarriages. Screening is usually conducted, especially for those with persistent, unexplained recurrent miscarriages in the first trimester. However, most patients might not seek medical attention earlier, causing a delay in screening. Nevertheless, it is a dilemma for patients with recurrent miscarriages, especially up to four miscarriages, to be presumed as APLS until proven otherwise. **Case**: We reported a 37-year-old Gravida 5 Para 0+4 at four weeks of amenorrhoea presented with one episode of per vaginal bleeding. APLS and other relevant causative screenings had been performed, and the results were normal. Surprisingly, her pregnancy is still viable and progressing well. **Discussion:** This case proved that recurrent miscarriages on more than three occasions are not always equivalent to antiphospholipid syndrome. The underlying cause can be idiopathic or other causes that have not been investigated yet, including the possibility of a congenital anomaly. **Conclusion:** Suspicion of APLS is warranted and should be verified with the gold standard screening tests. In any case, where the results were normal, further assessments such as uterine evaluation, infectious disease screening, and pathological examination should be considered. Pre-pregnancy screening should be a minimal requirement for all women of reproductive age for the evaluation and prevention of similar outcomes to those of other women.

Keywords: Antiphospholipid syndrome, recurrent miscarriages, suspicion

Introduction:

Early miscarriages, also known as spontaneous abortions, are a common occurrence in women of childbearing age (Battula et al., 2021). Various factors can contribute to early pregnancy miscarriages, including the mother's age, chromosomal abnormalities, endocrine disorders, thrombophilia, environmental factors, bacterial infections, and viral infections during pregnancy (Musik et al., 2021). Studies have highlighted the potential dangers of viral infections, such as rubella virus, cytomegalovirus, herpes simplex virus, and coxsackievirus B, in causing congenital anomalies and morbidity. The importance of investigating and identifying the causes of early pregnancy miscarriages is crucial for both the mother's future reproductive health and the potential prevention of future miscarriages (Zhu et al., 2023). Immunologic testing plays a crucial role in investigating potential causes of early pregnancy miscarriages. It helps to assess the immune response of the body and identify any underlying autoimmune disorders or immune system abnormalities that may be contributing to recurrent miscarriages (Pontius & Vieth, 2019).

Case Report:

A 37-year-old Gravida 5 Para 0+4 with four weeks of amenorrhoea came to the primary health clinic for an antenatal booking. All her previous miscarriages ranged from nine weeks to 11 weeks of gestation in 2011, 2013, 2018, and 2021, with no dilatation or curettage done. No investigation was performed previously, as all the incidents occurred in the early trimester without proper antenatal booking and did not require any hospital admission. She only sought medical attention as an outpatient at a private clinic. A bedside pelvic ultrasound revealed an empty uterus without any abnormalities. She also refused further tests, such as assessments for diabetes, autoimmune disease, and infections. Fortunately, she experienced no complications after each miscarriage. The bleeding resolved on its own for several days. She was stable on each occasion without any symptoms of anaemia. She denied any prior history of taking traditional medications, supplements, or traditional massages. She also had no history of trauma.

Her risks include advanced maternal age and maternal obesity with a BMI of 36.6kg/m2. She has no other significant medical history, no psychosocial stressors and receives good family support. Her blood pressure during the visit was 129/73mmHg. The patient's vital signs were normal and her physical examinations were all unremarkable.

The patient received a scheduled appointment for her gestational diabetes screening (OGTT) and other routine antenatal investigations. Additionally, the plaeed antiphospholipid antibody tests such as a Lupus anticoagulant, an anticardiolipin test, and a beta-2 glycoprotein test were sent to the tertiary centre laboratory. Fortunately, all results came back negative. She was advised to promptly seek immediate medical attention in case of abdominal cramps or vaginal bleeding.

During her follow-up after eight weeks of amenorrhoea, she remained well with no reported incidents of vaginal bleeding or pain. However, it was noted that she had visited the emergency department before her scheduled appointment due to a bout of vaginal bleeding. A pelvic ultrasound conducted during the emergency visit revealed a viable foetus and her cervical os was noted to be closed. She was managed as a threatened miscarriage case and received Duphastone® for one week as supportive treatment. Subsequently, her vaginal bleeding ceased, and her overall condition significantly improved. Her OGTT results were within normal limits. Subsequent follow-up and monthly antenatal checkups were uneventful, with serial ultrasounds indicating normal foetal growth parameters corresponding to gestational age and with adequate amniotic fluid levels. The patient also did not show any signs of anaemia or proteinuria, and her weight gain remained appropriate.

Her most recent follow-up was at 28 weeks of gestation. Her antiphospholipid antibody testing was normal. She remained asymptomatic, and the latest transabdominal revealed normal growth of her foetus without any complications.

Discussion:

Early pregnancy miscarriages are defined as the loss of a pregnancy before 20 weeks of gestation (Battula et al., 2021). These miscarriages can happen for various reasons, including chromosomal abnormalities in the foetus, hormonal imbalances in the mother, structural abnormalities in the uterus or cervix, and maternal health issues such as chronic diseases or infections (Zhu et al., 2023). To determine the cause of early pregnancy miscarriages, the following investigations and workups should be considered:

1. Medical History and Physical Examination: A detailed medical history of the patient, including previous pregnancies, reproductive history, mental status and emotional burdens, and any known risk

factors, can provide valuable insights into the potential causes of early pregnancy miscarriages (Musik et al., 2021; Zhu et al., 2023).

The physical examination may include assessing the general health of the patient, checking for any signs of infection, and evaluating the condition of the cervix and uterus for any abnormalities.

2. Genetic Testing: Chromosomal abnormalities are a common cause of early pregnancy miscarriages. Genetic testing, such as karyotyping or chromosomal microarray analysis, can be done to evaluate the foetal chromosomes and identify any abnormalities or aneuploidies that may have contributed to the miscarriage (Pontius & Vieth, 2019; Musik et al., 2021; Zhu et al., 2023).

3. Endocrine Evaluation: Hormonal imbalances, such as luteal phase deficiency, can affect the stability of the pregnancy. An endocrine evaluation can be conducted to assess the levels of hormones involved in maintaining a healthy pregnancy, such as progesterone and thyroid hormones (Pontius & Vieth, 2019; Musik et al., 2021; Zhu et al., 2023). However, in our local practice, these assessments are not conducted routinely unless there are clinical signs to suggest the disorder. For our patient, she has no clinical features to suggest any endocrine disorders.

4. Immunological Testing: Some research suggests that an immune response in the mother's body may contribute to early pregnancy miscarriages. Immunological testing, such as antiphospholipid antibody testing or anti-thyroid antibody testing, can be conducted to evaluate the immune response and identify any abnormalities that may be impacting the pregnancy (Musik et al., 2021; Li, Zheng, Zhao, Xu & Wang, 2021; Zhu et al., 2023).

5. Uterine Evaluation: Structural abnormalities of the uterus or cervix can increase the risk of early pregnancy miscarriages. A uterine evaluation can be performed to assess the structure of the uterus and cervix using imaging techniques such as ultrasound, hysteroscopy, or MRI (Pontius & Vieth, 2019; Musik et al., 2021; Zhu et al., 2023). In our local practice, most assessments conducted include cervical thickness measurement, especially in the second trimester for those with recurrent miscarriages that occur in the second trimester. However, in our case, the cervical length was not measured as her previous miscarriages were confined to the first trimester only, in which cervical insufficiency is unlikely.

6. Infectious Disease Screening: Bacterial and viral infections in the genital tract can increase the risk of early pregnancy miscarriages. Screening for infectious diseases, such as rubella, cytomegalovirus, herpes simplex virus, and bacterial infections, can be conducted to ascertain the presence of any infections that might have played a role in the miscarriage (Pontius & Vieth, 2019; Musik et al., 2021). This screening is recommended when patients exhibit symptoms such as vaginal discharges or any indicators of sexually transmitted diseases.

7. Pathological Examination: After a miscarriage, it may be beneficial to perform a pathological examination on the expelled foetal tissue. This can provide valuable information about the cause of the miscarriage, such as chromosomal abnormalities, infections, or structural abnormalities. Given the patient's history of early pregnancy loss, it would be prudent to conduct a thorough investigation to identify any underlying causes that may have contributed to the miscarriage (Pontius & Vieth, 2019; Musik et al., 2021; Arif, Zafar, Ahmed, & Shehzad, 2022). However, these crucial assessments were not conducted in our case previously.

Immunologic testing plays a crucial role in investigating potential causes of early pregnancy miscarriages (Musik et al., 2021; Li, Zheng, Zhao, Xu, & Wang, 2021). It helps to assess the immune response of the body and identify any underlying autoimmune disorders or immune system abnormalities that may be contributing to recurrent miscarriages. The most common immunologic tests used in the investigation of early pregnancy miscarriages include testing for anti-phospholipid antibodies (anti-PL) and anti-phospholipid antibodies (anti-PK). These antibodies have been implicated in early abortions and recurrent miscarriages in certain individuals. In a study conducted on a woman with a history of 13 miscarriages, it was found that reducing her anti-P titre with plasmapheresis prevented the miscarriage of her 14th pregnancy, supporting the proposal that anti-P is the immunologic cause of early abortion in women with Pk or p antigen (Arif, Zafar, Ahmed, & Shehzad, 2022). It is important to note that these tests should be interpreted in conjunction with the patient's clinical history and other investigations, as the exact mechanisms by which these antibodies contribute to miscarriages are not fully understood. In addition to the immunologic testing, it is essential to consider other possible aetiologies of early pregnancy miscarriages (Musik et al., 2021; Arif, Zafar, Ahmed & Shehzad, 2022; Zhu et al., 2023).

In the case of this 37-year-old woman with a history of four previous miscarriages, immunologic testing was considered to assessed her immune function and determine if any immunologic factors could be causing or contributing to her recurrent miscarriages. However, the investigations came back with normal results. Consequently, further investigations, such as uterine evaluation and pathological assessment, may provide a better understanding of her recurrent miscarriages. Unfortunately, as her previous miscarriages were not thoroughly investigated, her products of conception could not be examined. This case demonstrated that recurrent miscarriages—even exceeding three occurences—are not always indicative ofantiphospholipid syndrome. The underlying cause may be idiopathic or related to other causes that have yet to be explored, including the possibility of a congenital anomaly. The role of progesterone in recurrent miscarriages is indeed limited. Its role in threatened miscarriage, as experienced by this patient, is only confined to those within the first trimester and should not be given beyond that (Duncan, 2022).

Conclusion:

Recurrent early pregnancy miscarriages require thorough investigations and comprehensive workups. Suspicion of APLS is warranted and should be verified with the gold standard screening tests. In any case, where the results appear to be normal, additional assessments such as uterine evaluation, infectious disease screening, and pathological examination should be contemplated. Pre-pregnancy screening should be considered as a minimal requirement for all women of reproductive age to facilitate the evaluation and prevention of similar outcomes to those of other women.

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The Effects of Early Physiotherapy Intervention on Patients in Intensive Care Unit: A Systematic Review

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Abstract:

Introduction: Patients with a prolonged ICU stay may have several complications such as physical deconditioning and general body weakness which affect their overall quality of life. Physiotherapy intervention upon ICU admission may prevent such complications. Nevertheless, there is no solid conclusion on the benefits of early physiotherapy intervention on the occurrence of intensive care unit-acquired weakness (ICU-AW) syndrome and physical performance. Hence, this study is aimed to systemically synthesize the evidence of early physiotherapy intervention in decreasing the occurrence of (ICU-AW) syndrome and improving physical performance in ICU patients. **Methodology:** A systematic literature search was conducted in PubMed, Scopus, The Cochrane Library, and ScienceDirect databases. All relevant articles published in English between 2010 to 2022 were selected. The risk of bias assessment of the selected articles was performed using The McMaster Quantitative Critical Appraisal Tool (MQCAT). A narrative synthesis was employed to describe the findings. **Results:** After a thorough screening, four articles met the eligible criteria and were included in this systematic review for further analysis. The methodological quality of the selected articles was found to be satisfactory. The review revealed that positive outcomes of early physiotherapy intervention on ICU-AW were reported in three studies. Yet only one study reported positive outcome of early physiotherapy intervention on physical function outcome. **Conclusion:** This systematic review provides insight on the effects of early physiotherapy intervention on the incidence of ICU-AW as well as physical function that will inform the healthcare practitioners and future researchers.

Keywords: Early physiotherapy intervention, intensive care unit, intensive care unit-acquired weakness, physical performance

Introduction:

Intensive care unit (ICU) is a specialised comprehensive care unit for patients with any life-threatening illnesses which provide 24 hours of advance care and monitoring (Marshall et al., 2017). The length of ICU stays for each patient vary from a few days to a number of weeks and months depending on the severity of the illnesses (Toptas et al., 2018; Hunter et al., 2020; Vekaria et al., 2021; Zeleke et al., 2022). Lipshutz and Gropper (2013) stated that patients with serious medical conditions such as pulmonary edema, atelectasis, vasomotor instability, and contagious diseases require a longer period of ICU stay and bed rest.

While treatments delivered to critically ill patients in the ICU improve the survival outcomes, prolonged stay in the ICU leads to physical deconditioning and adversely affect the health status

(Hunter et al., 2020). Statistically, 40% of the ICU patients developed a neuromuscular dysfunction syndrome known as intensive care unit acquired weakness (ICU-AW) upon ICU discharge (Appleton et al., 2015). ICU-AW is a clinical diagnosis of muscle loss and weakness due to immobilization and it may exacerbate with catabolic condition associated with critical illness (Kramer, 2017). Several patients who were discharged from ICU have experienced persistent muscles weakness even after having fully recovered from the illness (Lad et al. 2020). Such complication may result in functional dependency.

Early mobilization upon ICU admission is crucial to mitigate the sequalae of bed rest (Castro-Avila, 2015; Sommers et al., 2015). According to a survey conducted by Cakmak et al. (2018), the most common treatments delivered by physiotherapists in the ICU include positioning, active range of motion (ROM) exercises, breathing exercise, passive range of motion (ROM) exercises, percussion, mobilization, vibration, and postural drainage, with the percentages of implementation were 90.8%, 90.8%, 89.2%, 87.7%, 87.7%, 86.2%, 86.2% and 86.2% respectively. Other than that, adjunct treatment such as neuromuscular electrical stimulation and cycle ergometer have been recommended for ICU patients particularly upon discharge from the critical care unit (Hashem et al., 2016).

Sommers and colleagues (2015) highlighted that early mobilization and rehabilitation for critically ill patients is essential to minimize the occurrence of ICU-AW syndrome as well as to improve patient's physical performance. Early mobilization which comprises of different types of physical exercises should be executed as early as second day of admission in the ICU (Castro-Avila, 2015). Several studies had been conducted to identify the effects of early mobilization and rehabilitation on ICU patients. However, the results are conflicting and inconsistent. Thus, this study is aimed to synthesize the published evidence on the effects of early physiotherapy intervention on patients in the ICU specifically on the occurrence of ICU-AW syndrome and also physical performance outcomes. The findings of this review may have significant impact on the clinical practice.

Methodology:

A Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) was used as a guideline in reporting the review. To preserve the methodological transparency, the protocol of this review is prospectively registered with the International Prospective Register of Systematic Reviews (PROSPERO) with the identification number of CRD42022370996. Institutional review board approval was granted prior to the initiation of the review.

Search Strategy

Searching and compiling the relevant studies were conducted through electronic databases which are PubMed, Scopus, The Cochrane Library and ScienceDirect. Boolean operators like 'AND', 'OR', or 'NOT' were employed. The searching procedure involved keywords that were related to the topic. The keywords include 'early physiotherapy mobilization', 'intensive care unit', 'intensive care unit-acquired weakness', 'physical performance', and 'ICU discharge'.

Screening and Study Selection

All retrieved articles from the databases search were collated in an electronic file. All titles of identified articles were screened preliminary by one researcher to remove any redundancies or duplicates and the remaining articles were recorded. Then, the abstracts of the articles related to the research questions and objectives of this systematic review were assessed. The remaining articles were then filtered based on the inclusion and exclusion criteria as shown in Table 1. The inclusion and exclusion criteria were defined based on PICOS framework (Table 2). The PICOS framework is convenient in addressing the criteria of the relevant study such as design of the study, population of the study, mode of treatment, outcomes of the study, and the comparison group, if any (Jain & Sharma, 2016). The excluded studies were recorded with specific reasons. The final number of studies remaining were recorded.

Methodological Quality Assessment

McMaster Quantitative Critical Appraisal Tool (MQCAT) was used to assess the methodological quality of the studies included (Law et al., 1998). This tool is relevant to all quantitative study designs. This tool examined eight main components which are study purpose, study background, study design, sample size justification, reliability and validity of outcome measures, description, contamination and co-intervention regarding intervention, statistical significance and appropriate analysis methods, dropout reporting and conclusion. The total score of the MQCAT was 14, where better methodology quality is indicated by the higher score.

Table 1: Inclusion and Exclusion Criteria

Inclusion Criteria
Studies which involve patients aged more than 18 years old
Studies include patients with any intensive care unit (ICU) admission diagnoses
Studies include patients who receive physiotherapy intervention since the first week of intensive care unit (ICU) admission
Studies include outcomes on the effects of early physiotherapy intervention on ICU-AW and physical performance
Studies published in between 2010 to 2022
Studies written in English language
Studies include any experimental study design
Exclusion Criteria
Studies include patients who receive physiotherapy intervention after intensive care unit (ICU) discharge

Table 2: PICOS Table

Population	Adult patients (>18 years old) who were admitted to the ICU more than 24 hours with any admission diagnoses
Intervention	Any early physiotherapy intervention commenced at the first week of ICU stay
Control	Receive only usual or standard care during ICU stay
Outcome	Any outcome on ICU-AW and physical performance
Study Design	Any experimental study design

Data Analysis

Information on the study design, study population, outcome measure, interventions and results were extracted by one researcher and then was crosschecked by another researcher. All extracted data were portrayed in a table. As the meta-analysis is not possible to be conducted due to heterogeneity in the intervention protocols and outcome measures used in the individuals articles, outcomes on the effects of early mobilization were synthesised narratively.

Results:

Study Selection

During the study selection, EndNote was used to collect and classify the articles. A total of 527 articles were retrieved from PubMed (n=66), ScienceDirect (n=388), The Cochrane Library (n=29) and Scopus (n=44). A total of 139 duplicate studies were identified and removed, which led to 388 articles screened by their titles and abstracts. After screening the titles and abstracts, 341 articles were excluded as they were totally not related to this study. The remaining 47 articles were then evaluated according to the pre-determined inclusion and exclusion criteria. Finally, 43 articles were excluded due to specific reasons as outlined in Figure 1. Finally, four articles were included in this systematic review.

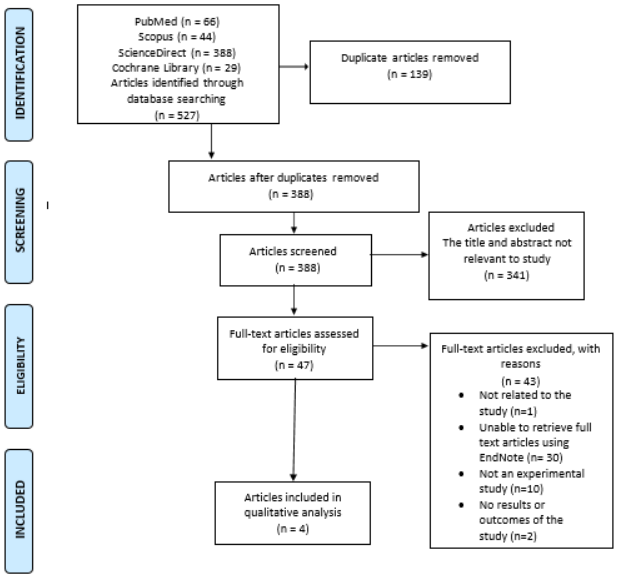

Figure 1 PRISMA flow diagram for each stage of the study (Moher et al., 2009)

Study Characteristics

There are four articles included in this study where three of them were randomised controlled trials and one article was a historical control study. The number of participants recruited in the included articles is ranged from 38 to 115 participants with various medical illness, while the mean age range is from 44 to 70 years old. All included articles mentioned that the participants began the physiotherapy rehabilitation or intervention in the early days of ICU admission. Kayambu et al. (2015) conducted the intervention within 48 hours of diagnosis in the ICU, while Machado et al. (2017) began the mobilization on the first day as patient was cooperative and responsive. Nakano et al. (2021) started the rehabilitation on the first day after ICU admission while Eggmann et al. (2018) only mention the term 'early' without mentioning the exact time. Detailed descriptions of the studies included author/year, study design, number of participants, mean age of participants, outcome measures, interventions and results of the studies are outlined in Table 3.

Table 3: Characteristics of Included Studies

Author/Year	Study design Risk of Bias	Participants Mean Age Inclusion Criteria Study Setting	Outcome measure(s) used for ICU-AW and physical performance/function	Interventions	Effects of early physiotherapy intervention on ICU-AW and physical performance/function
Kayambu et al. (2015)	Prospective double blinded RCT	n = 50 *Mean Age* • IG: 62.5 • CG: 65.5 *Inclusion Criteria* 1) ≥18-year-old 2) Remained mechanically ventilated ≥48 hours 3) Diagnosed with sepsis, severe sepsis, and septic shock *Study Setting* General ICU at the Royal Brisbane and Women's Hospital, Brisbane, Queensland, Australia	*ICU-AW*: 1) Medical Research Council Muscle Score (MRC) *Physical function*: 1) Acute Care Index of Function (ACIF) 2) Self-reported health related QoL 3) Physical functional ICU test (PFIT) *Remark*: All objective measurements for ICU-AW and physical function were taken once upon ICU discharge while subjective measurements were at 6 months of post-discharge from hospital	*IG (n = 26)* Early targeted physical rehabilitation program in the ICU (The intervention begun within 48 hours of diagnosis in the ICU) *CG (n = 24)* Standard ICU care (The first session was not determined) *Rehabilitation program (both groups)*: Ambulation, standing balance exercises, sitting balance exercises, marching on the spot, sit to stand, sitting out of bed, sitting up in bed, active resistive exercise, active ROM, passive ROM)	*ICU-AW:* MRC score for IG was high as compared to CG, indicating the occurrence of ICU-AW was low, but the difference was not significant between the IG and CG ($p>0.05$) *Physical function:* 1) Self-reported QoL: There were significant improvements in the intervention group in the domains of physical function ($p<0.05$)
Machado et al. (2017)	RCT	n = 38 *Mean Age* • IG: 45.13 ± 18.91 • CG: 44.64 ± 19.23	*ICU-AW:* 1) Medical Research Council (MRC) scale	*IG (n = 22)* Conventional physical therapy and passive exercise on leg cycle ergometer *CG (n = 16)*	*ICU-AW:* Within group analysis: Peripheral muscle strength had significantly increase at post intervention in both groups ($p<0.01$)

		Inclusion Criteria 1) ≥18 years 2) On MV 3) Maintained at light level of sedation 4) Hemodynamically stable *Study Setting* ICU of the Santa Maria University Hospital of the Federal University of Santa Maria, Brazil		Conventional physical therapy only *Remark*: First physiotherapy session of conventional physical therapy started as early as 24-48 hours	Between group analysis: IG had significantly greater increase in the MRC scale scores than the CG ($p<0.01$)
Eggmann et al. (2018)	Single-center, parallel, two-arm, assessor-blinded RCT	n = 115 *Mean Age* • IG: 65 ± 15 • CG: 63 ± 15 *Inclusion Criteria* 1) Adult (≥18 years) 2) Expected to stay on MV for at least 72 hours 3) Independent before onset of critical illness *Study Setting* ICU of the Department of Intensive Care Medicine at the Inselspital, Bern University Hospital, Switzerland	*ICU-AW:* 1) Medical Research Council (MRC) *Physical performance:* 1) 6-Minute Walking Distance (6MWD) 2) Functional Independence Measure (FIM) 3) Timed 'Up & Go' (TUG) test 4) Short Form 36 (SF-36) *Remark*: All measurements for ICU-AW and physical performance were taken once, either at ICU discharge or hospital discharge	*IG (n = 58)* Early, progressive ERT program (motor-assisted bed-cycle, UL and LL exercises with weights or manual resistance) combined with early mobilisation. *CG (n = 57)* Early mobilisation, respiratory therapy and passive or active exercises *Early mobilisation*: On-bed exercises, progressively sitting on bedside, sitting on chair, standing and walking. *Remark*: First physiotherapy session started within 48 hours	*ICU-AW:* The incidence of ICU-AW at post intervention in IG was low 3% as compared to CG but the difference was statistically insignificant ($p>0.05$) *Physical performance:* Significant difference for physical performance parameters were not found ($p>0.05$)

Nakano et al. (2021)	Single-center, historical control study	n = 101 *Mean Age* • IG: 70.9 • CG: 70.9 *Inclusion Criteria* 1) Admitted to ICU *Study Setting* Hitachi General Hospital	*ICU-AW:* 1) Medical Research Council (MRC) *Physical performance:* 1) ICU Mobility Scale (IMS) 2) Grip strength 3) Functional status scores for ICU (FSS-ICU) 4) Barthel Index *Remark*: All measurements for ICU-AW and physical performance were taken once at ICU discharge	*IG (n = 56)* Protocol-based intervention, Intensive goal-directed rehabilitation with electrical muscle stimulation and nutrition (IGREEN) protocol. *CG (n = 45)* Standard care without NMES *Remark*: First rehabilitation session started on day 1 after entering the ICU	*ICU-AW and physical performance:* Significant difference for ICU-AW and physical performance were not found for all outcomes (p>0.05)

Note. RCT= Randomized Controlled Trial; IG= Intervention Group; CG= Control Group; MV= Mechanical Ventilation; QoL= Quality of Life; ROM= Range of Motion; ERT= Endurance and Resistance Training; UL= Upper Limb; LL= Lower Limb; NMES= Neuromuscular Electrical Stimulation; ICU= Intensive Care Unit; FMV= Femoral Muscle Volume

Methodological Quality of Included Studies

The methodological quality assessment was evaluated and the overview of the scores is displayed as in Table 4. The total score for the included studies is ranged from 10 -12 out of 14 which indicated a promising methodological quality. All of the studies did not report contamination and co-intervention regarding intervention, and almost all of the studies (n = 3) did not report the clinical importance of the results.

Table 4: Quality Assessment for Included Studies

Authors	Criteria																
	1	2	3	4a	4b	4c	5a	5b	6a	6b	6c	7a	7b	7c	7d	8	TS
Kayambu et al. (2015)	Y	Y	RCT	50	Y	Y	Y	Y	Y	N	N	Y	Y	N	Y	Y	11
Machado et al. (2017)	Y	Y	RCT	38	Y	N	Y	Y	Y	N	N	Y	Y	N	Y	Y	10
Eggmann et al. (2018)	Y	Y	RCT	115	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	12
Nakano et al. (2021)	Y	Y	HCS	101	Y	Y	Y	Y	Y	N	N	Y	Y	N	Y	Y	11

Abbreviations: N, no/not addressed/not applicable (0 point); Y, yes (1 point); RCT, randomized control trial; HCS, historical control study; TS, total score

1, study purpose stated clearly; 2, relevant background literature reviewed; 3, research design appropriate; 4a, sample size; 4b, sample described in detail; 4c, sample size justified; 5a, outcome measures reliable; 5b, outcome measures valid; 6a, intervention/exposure described in detail; 6b, contamination avoided; 6c, co-intervention avoided; 7a, results were reported in terms of statistical significance; 7b, appropriate analysis methods; 7c, clinical importance; 7d, dropouts avoided; 8, appropriate conclusions

Table 5: Effects of Early Physiotherapy Intervention

Articles	Effects of early physiotherapy intervention on	
	ICU-AW	Physical performance/function
Kayambu et al. (2015)	Muscles strength score increase in the IG but there is no significant difference between the IG and CG ($p>0.05$)	Significant improvement in physical function domain ($p<0.05$)
Machado et al. (2017)	Significant improvement of muscles strength at post intervention ($p<0.01$).	Not reported
Eggmann et al. (2018)	Number of ICU-AW in IG was low as compared to CG but insignificant ($p>0.05$)	No significant improvement ($p>0.05$)
Nakano et al. (2021)	% of muscle loss is low in both groups ($p<0.05$). MRC score did not differ between IG and CG ($p>0.05$)	No significant improvement ($p>0.05$)

The Effects of Early Physiotherapy Intervention on ICU-AW and Physical Performance

All the included articles in this systematic review examined the effects of early physiotherapy intervention in ICU patients by comparing the early physiotherapy mobilization in combination with adjunct exercises with the standard early physiotherapy mobilization alone. To measure the outcomes, all the four included articles used MRC grading scale to indicate the incidence of ICU-AW. For physical function or physical performance, there are various outcome measures used by the studies such as Acute Care Index of Function (ACIF), Physical Functional ICU test (PFIT), 6-Minute Walking Distance (6MWD), and Functional Independence Measure (FIM). Eggmann et al. (2018) and Nakano et al. (2021) reported that ICU-AW and physical performance outcomes are only measured at post-intervention. The possible explanation was that the researchers only measured when the patients are physically stable as the assessments requires patients who are responsive and cooperative.

As shown in Table 5, three studies found that participants who received early physiotherapy had improved MRC scores and reduced occurrence of ICU-AW syndrome, however, the score was higher in those who received adjunct treatments as compared to the early mobilization alone (Kayambu et al., 2015, Eggmann et al., 2018). Furthermore, according to between group analysis, there was no significant difference between the two groups ($p > 0.05$). In contrast, Machado et al. (2017) found significant difference between the groups with and without adjunct interventions in which the improvement is evident in the group that received combination treatments as compared to group with early mobilization alone (Machado et al., 2017).

In this review, Nakano et al (2021) revealed that the percentage of muscle loss is significantly lower among those who received early mobilisation and adjunct intervention ($p < 0.05$). Nevertheless, the MRC scores did not differ between the two groups. As for physical performance, Kayambu et al. (2015) reported that early mobilization with adjunct intervention significantly improved functional performance ($p < 0.05$). While Eggmann et al. (2018) and Nakano et al. (2021) found the results to be different from those of Kayambu et. al. (2015). Machado et al. (2015), in this review, did not measure the effects of early mobilization on physical function.

Discussion:

The objective of this systematic review is to determine the effects of early physiotherapy intervention on ICU-AW and physical performance among patients in the ICU. Studies included have described the time point for 'early mobilization' ICU patients, except for Eggmann et al. (2018) which did not mention the exact time for their early mobilization approaches. All studies which included leg cycle ergometer, resistive exercises, rehabilitation with NMES, and usual intervention such as positioning, sitting out of bed, active and passive ROM exercises and respiratory rehabilitation.

ICU-AW commonly occurs among critically ill patients in the ICU who are immobilized for a long period and who suffer with sepsis, multiple organ failure, persistent systemic inflammation and other critical diagnosis (Zorowitz, 2016). Several studies have found that commencing physiotherapy intervention and rehabilitation on ICU patients at the early phase of ICU stay is beneficial and has positive effects. Zang et al. (2019) stated that early mobilization could reduce the incidence of ICU-AW, improve in MRC score, and improve functional mobility at hospital discharge. This review found that early mobilization could prevent muscles loss (Nakano et al., 2021) which result in the low percentage of ICU-AW syndrome among ICU patients as reported by Eggmann et al. (2018). In addition, the MRC scores upon ICU discharge were improved with early mobilization alone or with the combination of other treatments. In this review, the researchers are aware that early mobilization alone has potential to alleviate the occurrence of ICU-AW. But at the same time, the combination with other treatments may have a more remarkable impact.

In this systematic review, significance difference in physical function between those who received early mobilization or with other treatments was not found in studies by Eggmann et al., 2018 and Nakano et al., 2021. Only Kayambu et. al., (2015) reported positive effects of early physiotherapy intervention on peripheral muscle strength. In this study, the patients received conventional physical therapy and passive leg cycle ergometer exercise. The exercise was performed for 20 minutes at a fixed rate of 20 cycles/minutes and conducted for 5 days per week until the patients discharged from the ICU. The patients are hemodynamically stable and maintained at light level of sedation. The condition of the patients might influence the effectiveness of the exercise to improve muscle strength. In addition, according to Camargo Pires-Neto et al. (2013), early passive cycling exercise conducted on sedated, critically ill and less than 72 hours mechanically ventilated patients was found to be safe and feasible as it was not associated with hemodynamic and metabolic changes.

In the ICU, patients received a range of intensive care and management from the multidisciplinary healthcare team such as from the physicians, nurses, and physiotherapists as according to their specific needs and severity of the condition (Marshall et al., 2017). The management includes mechanical ventilation (MV), medications, nutritional support, physical therapy and close monitoring equipment such as monitors to track heart rate and blood pressure, and oxygen saturation monitors (Hashem et al., 2016; Cakmak et al., 2018). These treatments might influence patients' outcome either at ICU discharge, hospital discharge or months after the discharge.

It is worth noting that there are significant findings in the improvement of quality of life in the domains of physical role in the study done by

Kayambu et al. (2015). Therefore, ICU physiotherapists are recommended to commence early physiotherapy intervention on ICU patients as it promotes positive impacts to the health domains.

Limitation of the Study

There are some limitations of this review: Firstly, it is limited to only experimental studies, although there are many observational studies related to this topic in the literature, the later was excluded in alignment with the inclusion criteria of this review. Secondly, there were limited articles available which compared the effects between early and no mobilisation in the ICU. Thirdly, the selected articles did not perform baseline measurements for ICU-AW and physical performance. This is somewhat a drawback as the researchers were unable to explore the differences between these studies in-depth.

Recommendation for Future Studies

Larger study is needed to determine the long-term effects of early mobilization in the ICU patients. Moreover, it is equally important for future research to establish a standard guideline and protocol for early mobilization approaches in order to enhance the quality of care and also upholding the best standard of practice in the critical care units.

Conclusion:

In conclusion, early physiotherapy intervention was found to be beneficial and can be considered as crucial in the prevention of ICU-AW syndrome as well as functional dependency. It is suggested that early mobilization should be conveyed to ICU patients immediately upon admission as it is safe, feasible and beneficial. Early mobilization alone or with adjunct treatments offer positive outcomes on ICU-AW and physical performance. These findings may help the clinicians to strategise the best approaches in improving the clinical outcomes for ICU survivors.

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Mapping the Intellectual Structure of Telehealth Research in Geriatrics: A Bibliometric Analysis

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Abstract:

Introduction: The current investigation seeks to perform a bibliometric analysis of the geriatric telehealth research literature disseminated from 1989 to 2023. The objective will be achieved through the utilization of the databases known as Scopus and Web of Science. **Methodology:** To exhibit the bibliometric study, open-source tools, namely ScientoPy and VOS viewer, are utilized. We also identified the contributions of journals, countries, and widely cited articles. **Results:** European nations, dominating most publications on this topic, have made significant contributions to recovery research in telehealth-related studies among older adults. Notably, the Journal of Telemedicine and Telecare has been granted the opportunity to disseminate the most publications in this specific field. The most common co-occurring terms were shown and mapped visually to represent the relationships, specifically highlighting each connection. The paper entitled "A systematic review of the benefits of home telecare for frail elderly people and those with long-term conditions" had the most citations with 242. **Conclusion:** This bibliometric analysis will make it worthwhile for an apprentice to survey ongoing research on telehealth in the geriatric population.

Keywords: Bibliometric Analysis, Co-citation analysis, Geriatrics, Telehealth, Rehabilitation

Introduction:

The population of individuals aged 65 and above is expected to reach 1.5 billion by 2050, making the aging population one of the world's fastest-growing demographic groups. According to WHO (2022), we can determine that people become more prone as they age to chronic health issues, impairments, and disabilities that call for ongoing medical care and support (Chou et al., 2021). Additionally, because of their complex medical requirements, older adults frequently have higher healthcare costs than their younger counterparts.

The primary enablers or barriers preventing older adults from accessing healthcare services were frequently identified as being accessibility and acceptability (Mohd Rosnu et al., 2022).Therefore, to effectively address the specific healthcare needs of older adults while ensuring accessibility, innovative and cost-effective approaches to healthcare delivery, such as telehealth or online interventions, are required. Telehealth has been defined as "the use of electronic information and telecommunications technologies to support and promote long-distance clinical health care, patient and professional health-related education, public health, and health administration (WHO (2022). This change has been made possible by healthcare providers' increased use of telehealth, increased access to technology, and older adults' acceptance and adoption of telehealth (Alsabeeha et al., 2023; Bhatia et al., 2022).

This enables timely and efficient assessments, facilitating appropriate management and care planning for older adults. Regarding the effectiveness of interventions through telehealth among older adults, multiple research studies have shown favorable results in various domains, including chronic disease management(Sánchez-Gutiérrez et al., 2022), mental health support (Belanger & Winsberg, 2022), and musculoskeletal health (Jirasakulsuk et al., 2022).

A recent scoping review exploring the utilization of telehealth and the commonly used platforms among older adults with mild cognitive impairment (MCI) or cognitive frailty (CF) revealed that telephones or smartphones with internet capabilities were the most prevalent technology used, followed by television-based assistive integrated technologies, mobile applications, and video conferencing (Fadzil et al., 2022). It is noteworthy that while the evidence supports the effectiveness of telehealth in assessment and management among older adults, certain considerations such as technological barriers, access to appropriate devices, and the need for caregiver assistance may influence individual experiences and outcomes (Hall et al., 2022). An overall portrait of telehealth research in geriatrics is still not available. Given this, a bibliometric analysis has the potential to provide valuable insights for evidence-based practice and policy development in this area of interest (Azizan et al., 2024).

Significant pre-processing was conducted to ensure the quality of the data, resulting in a polished dataset that has been set up for further analysis and examination. This investigation aimed to address the following research questions to highlight key aspects related to telehealth research in geriatrics:

RQ1: How many publications and growth trends over the years and how did the study evolve?

RQ2: Which journals have published the most articles on telehealth in geriatrics?

RQ3: Which countries are the biggest contributors to telehealth research in geriatrics, and how has their contribution changed over time?

RQ4: What articles in telehealth research within the geriatrics sector have the highest number of citations, and what are their primary results or contributions?

Methodology:

Procedure Analysis

We used Scopus and the Web of Science (WoS) databases in our search for this study, which was performed on May 21, 2023, focusing on the years 1989–2023. The reason for this selection includes having an extensive citation and abstract database of peer-reviewed scientific publications (Pranckutė, 2021) and ease of use with multiple software programs, allowing the retrieval of essential information for bibliometric analysis. The expert's opinion is considered while defining the essential keywords in the bibliometric analysis of "telehealth in older adults." Table 1 shows the division of essential keywords into two identified keywords and search queries.

Table 1: Identified keywords

Identified Keywords	
"telehealth"	**"Older adults"**
Telehealth telemedicine remote health care services, remote patient monitoring, telecare	Older adults elderly, seniors Geriatric

Table 2: Search queries

Search Queries
("telehealth" OR "telemedicine" OR "remote health care services" OR "remote patient monitoring" OR "telecare" AND "older adults" OR "elderly*" OR "senior*" OR "geriatric*").

Data Analysis

Figure 1 shows the diagram of the search process. The pre-processing of bibliographic datasets was performed using the ScientoPy tool (Ruiz-Rosero, Ramirez-Gonzalez, & Khanna, 2019), and the VOS viewer (Nees et al., 2019) was used to generate co-occurrence maps of keywords related to telehealth and older persons and to conduct network and bibliometric analyses. To retrieve article metadata, a keyword search was conducted in the Scopus and WoS databases that included searching for the titles "telehealth "OR "telemedicine" OR "remote health care services" OR "remote patient monitoring" OR "telecare" AND "older adults" OR "elderly" OR "senior*" OR "geriatric*". A filter was simultaneously applied to look for papers exclusively written in English. The documents included in the search were limited to articles, proceeding papers, and review papers.

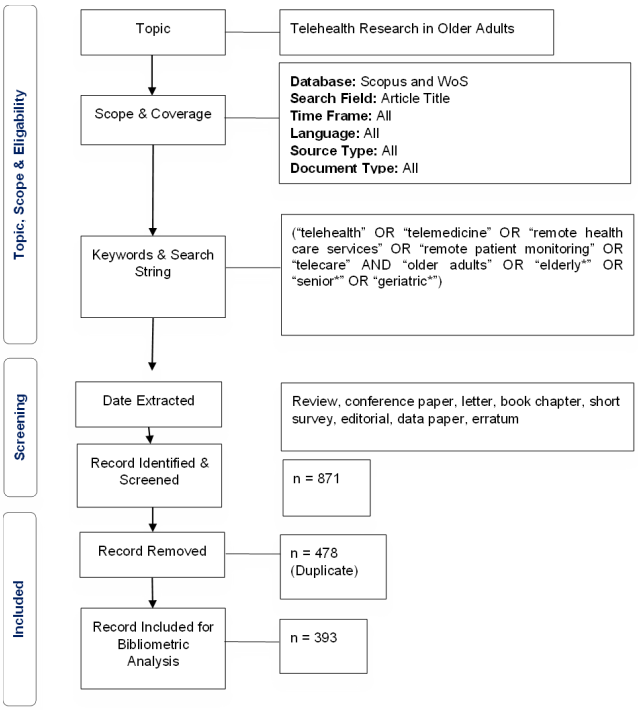

Figure 1: Diagram of the search process

Initially, the dataset consisted of 871 papers. However, 230 papers were omitted based on their document type, including review, conference paper, letter, book chapter, short survey, editorial, data paper, and erratum accounting for approximately 26.4% of the original dataset. After removing these omitted papers, the remaining dataset comprised 641 papers. Among the loaded papers, 44% (282 papers) were retrieved from the Web of Science (WoS) database, while 56% (359 papers) were obtained from the Scopus database. This distribution highlights the utilization of multiple sources to gather a comprehensive collection of relevant papers. The analysis further identified 249 duplicate papers (38.8% of the dataset). Only one duplicate paper was found in the WoS dataset, representing a mere 0.4% of the total duplicates. In contrast, 248 duplicate papers (69.1%) were removed from the Scopus dataset. Additionally, 181 duplicate papers showed variations in the number of citations they received. After the removal of duplicates, the dataset was reduced to 393 papers. Among these, 71.7% (281 papers) originated from the WoS database, while the remaining 28.3% (111 papers) were sourced from Scopus.

The list of publications used in the current study exceeded the minimum criterion of 300, as stipulated by (Donthu et al., 2021), and is deemed suitable for conducting bibliometric analysis. Furthermore, Glänzel and Moed(2013) asserted that conducting a bibliometric review requires a minimum of 100 publications. The final statistics after the duplication removal filter reveal the distribution of papers based on their document types within each database. Notably, the WoS dataset contained a higher proportion of articles, reviews, and proceedings papers compared to Scopus. This differentiation showcases the unique characteristics and focus areas of each database in terms of the document types they index. In addition, the VOS Viewer program was used to conduct network and bibliometric analyses.

Results:

Publication Trends and Growth Rates

The dataset exhibited in Figure 2 provides an illustrative demonstration of the publication trends and growth outcomes over an extended period between the Web of Science (WoS) and Scopus databases. The annual growth rate (AGR) reveals fluctuations in publication growth over the years. WoS exhibited both positive and negative AGR values, indicating periods of accelerated growth and periods of slower expansion. On the other hand, Scopus maintained a relatively stable AGR of around 0, suggesting a consistent rate of publication growth.

WoS consistently demonstrated higher average daily yield (ADY) values compared to Scopus. This discrepancy might be attributed to differences in the rate of article inclusion and indexing in the respective databases. The h-index for WoS was consistently higher than Scopus, suggesting that the publications indexed in the WoS database tend to receive more citations, indicating a potentially higher overall research impact.

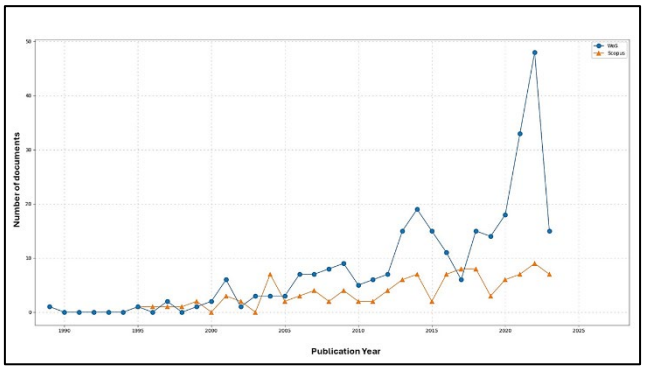

Figure 2: Publication trends and growth rates

Top Journals Publishing Telehealth and Older Adults Research

Table 3 showcases the top journals publishing papers related to telehealth and older adults. The Journal of Telemedicine and Telecare has established itself as a prominent publication in this field, with 27 published papers and a high Cite Score of 12.6. Telemedicine and e-Health, the Journal of the American Geriatrics Society, and the Journal of Medical Internet Research are also among the top journals publishing in this area.

Table 3: The top ten most productive journals

No	Journal	TP	Cite Score 2022	SJR 2022	SNIP 2022	Publisher
1	Journal of Telemedicine and Telecare	27	12.6	1.223	1.647	SAGE
2	Telemedicine and E-health	19	8.1	1.237	1.601	Mary Ann Liebert
3	Journal of the American Geriatrics Society	12	10.4	2.054	2.072	Wiley-Blackwell
4	Journal of Medical Internet Research	6	12.1	1.992	2.162	JMIR Publications Inc.
5	International Journal of Environmental Research and Public Health	5	5.4	0.828	1.280	Multidisciplinary Digital Publishing Institute (MDPI)
6	Journal of Applied Gerontology	5	4.8	1.061	1.516	SAGE
7	Research in Gerontological Nursing	5	2.1	0.501	0.496	Slack Incorporated
8	BMC Geriatrics	4	5.1	1.127	1.546	Springer Nature
9	Journal of Geriatric Oncology	4	5.8	1.025	1.065	Elsevier
10	Journal on Information Technology in Healthcare	4	-	0.128	0.442	Optimum

Notes: Abbreviations, total publication;NCP,number of cited publications; TC, total citation, C/P, average citations per publications; C/CP, average citation per cited publication; h, h-index; g, g-index

Publishing research by top countries

Figure 3 presents the top and active countries publishing articles related to telehealth in older adults. The United States stands out as a leader in this field, with a significant lead in the total number of published articles (163). France, Canada, the United Kingdom, and China also demonstrate consistent research efforts in exploring telehealth applications for older adults.

Top cited publications (minimum of 100 citations)

Table 4 exhibits the preeminent papers in the realm of telehealth for the elderly, wherein only those garnering a minimum of 100 citations have been considered. Barlow, Singh, Bayer, and Curry (2007), performed a comprehensive analysis, published in the esteemed Journal of Telemedicine and Telecare, that has accrued an astounding 242 citations. The paper explores the benefits of home telecare for frail elderly individuals and those with long-term conditions.

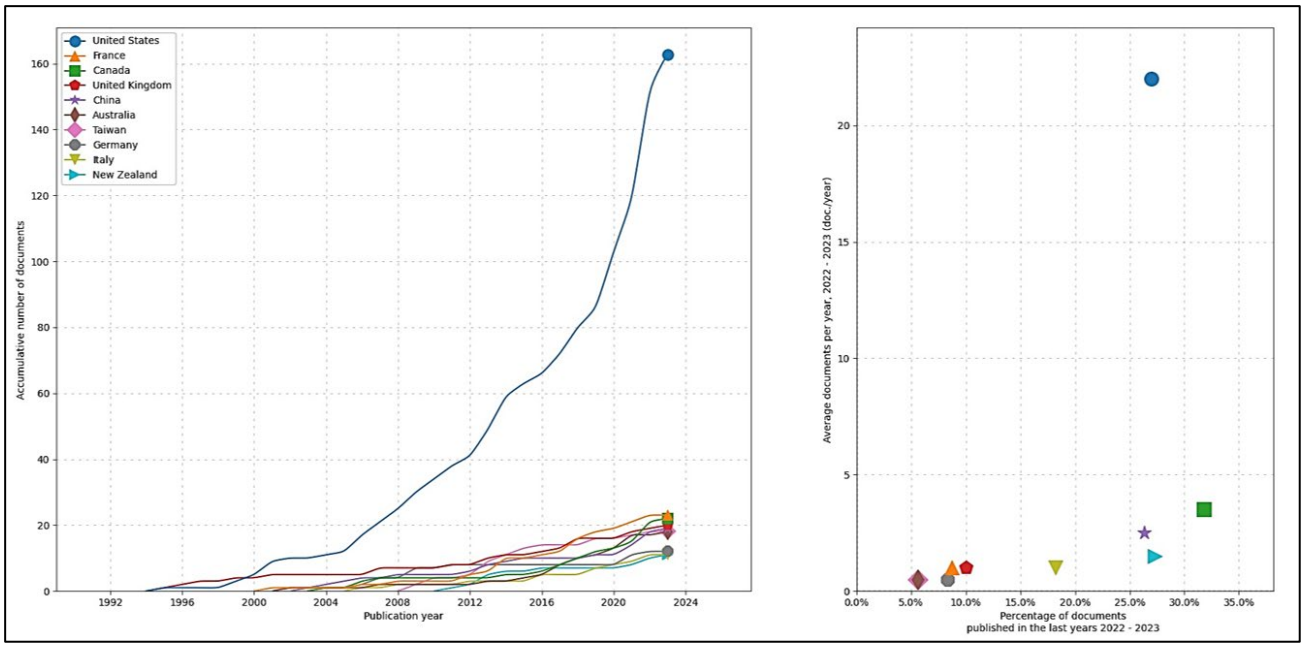

Figure 3: Publishing research by top countries

Table 4: Highly cited publications (Minimum of 100 citations)

Titles	Author(s)	Citations	Source Title
A systematic review of the benefits of home telecare for frail elderly people and those with long-term conditions	Barlow J, Singh D, Bayer S, Curry R	242	Journal of Telemedicine and Telecare
Telehealth Home Support During COVID-19 Confinement for Community-Dwelling Older Adults with Mild Cognitive Impairment or Mild Dementia: Survey Study	Goodman-Casanova JM, Dura-Perez E, Guzman-Parra J, Cuesta-Vargas A, Mayoral-Cleries F.	185	Journal of Medical Internet Research
Older Adults' Perceptions of Home Telehealth Services	Cimperman M, Brenčič MM, Trkman P, Stanonik M de L.	121	Telemedicine and E-Health
Current status and future perspectives in telecare for elderly people suffering from chronic diseases.	Botsis T, Hartvigsen G.	119	Journal of Telemedicine and Telecare
Outcomes of a Telehealth Intervention for Homebound Older Adults with Heart or Chronic Respiratory Failure: A Randomized Controlled Trial	Gellis ZD, Kenaley B, McGinty J, Bardelli E, Davitt J, Ten Have T.	113	Gerontologist
Six-Month Postintervention Depression and Disability Outcomes of In-Home Telehealth Problem-Solving Therapy for Depressed, Low-Income Homebound Older Adults	Choi NG, Marti CN, Bruce ML, Hegel MT, Wilson NL, Kunik ME.	108	Depression and Anxiety
Telehealth Problem-Solving Therapy for Depressed Low-Income Homebound Older Adults	Choi NG, Hegel MT, Marti CN, Marinucci ML, Sirrianni L, Bruce ML.	103	American Journal of Geriatric Psychiatry

The high citation count suggests that this comprehensive review has had a significant impact on the field, likely due to its thorough evaluation of the advantages of home telecare in supporting older adults with complex healthcare needs. Their research was recently published in the prestigious Journal of Medical Internet Research, where it received a noteworthy 185 citations (Goodman-Casanova et al., 2020).

Given the relevance of telehealth during the global health crisis, the study's findings and insights have garnered significant attention within the research community, leading to its high citation count. The study conducted by (Cimperman et al., 2013) investigated the attitudes and experiences of older adults concerning home telehealth services. This study has amassed a total of 121 citations in the prestigious journal Telemedicine and e-Health. Their investigation offers valuable insights into the perceptions of this population regarding such services.

The findings of Botsis and Hartvigsen (2008), disseminated their findings in the esteemed Journal of Telemedicine and Telecare, garnering an impressive 119 citations. Their research affords valuable insights into the existing state and forthcoming prospects of telecare for geriatric individuals afflicted with persistent maladies. The examination of the possible advantages and difficulties of telecare is likely to have enhanced its influence and number of citations, as it provides vital insights for healthcare professionals and policymakers. The randomized controlled study conducted by Gellis et al., (2012) in the field of gerontology has received 113 citations. The study's findings are a valuable addition to the field of telehealth interventions for depression management in this population, as the paper addresses a critical mental health concern among older adults.

Discussion:

The findings from this bibliometric analysis provide valuable insights into the intellectual structure and research trends in the field of telehealth for geriatric populations (Kang et al., 2021). The fluctuations in publication growth rates and the differences in database coverage and citation patterns observed between WoS and Scopus highlight the need for a comprehensive and harmonized approach to capturing and analyzing research in this domain (Singh et al., 2021).

The dominance of the United States in telehealth research for older adults is likely attributable to its robust research infrastructure, technological advancements, and sustained efforts to address the healthcare needs of the aging population (Goldberg et al., 2021). This aligns with findings from previous studies that have identified the United States as a global leader in telehealth research and implementation (Lieneck et al., 2021; Rangachari et al., 2021) The contributions of other leading countries, such as France, Canada, the United Kingdom, and China, demonstrate the growing global interest and investment in leveraging telehealth to improve the well-being of older adults (Anthony Jnr, 2020). This trend reflects the increasing recognition of telehealth as a valuable tool for addressing the unique healthcare needs of the geriatric population worldwide.

The identification of top-performing journals in this field underscores the importance of specialized and high-impact platforms for disseminating cutting-edge research and facilitating knowledge exchange. These journals play a crucial role in shaping the research agenda and driving advancements in telehealth applications for geriatric populations (Sahoo et al., 2023). This finding is consistent with previous studies that have highlighted the significance of specialized journals in fostering research and innovation within specific domains (Pramod, 2022).

The highly cited publications provide a snapshot of the influential work that has significantly shaped the understanding and development of telehealth interventions for older adults. These studies offer valuable insights into the benefits, perceptions, and challenges associated with telehealth services, which can inform future research, policymaking, and clinical practice (Ladin et al., 2021; Kristin Jonasdottir et al., 2022). This aligns with the growing body of evidence that suggests telehealth can effectively address the diverse healthcare needs of the geriatric population, ranging from chronic disease management to mental health support (Kirakalaprathapan & Oremus, 2022).

The strength of this bibliometric analysis lies in its comprehensive approach to mapping the intellectual structure of telehealth research in geriatrics. By examining publication trends, growth rates, top journals, and highly cited publications, the study offers a multifaceted understanding of the research landscape in this field. However, it is important to acknowledge that the analysis is limited to the data available in the Web of Science and Scopus databases, which may not capture the entirety of the research landscape (Nwagwu & Onyancha, 2022). Additionally, the findings are based on the state of

research up to August 2023, and the landscape may have evolved further since then. Ongoing monitoring and updates to this analysis would be necessary to capture the most recent trends and developments in this rapidly evolving field.

Overall, this bibliometric analysis provides a comprehensive overview of the research landscape in telehealth for geriatric populations, highlighting the global engagement, influential work, and the need for a harmonized approach to capturing and analyzing research in this domain. The insights gained can inform future research, guide funding priorities, and support the development of effective telehealth interventions to address the healthcare needs of older adults.

Conclusion:

This bibliometric analysis suggests that there has been a significant increase in research regarding telehealth in recent years. It is important to note that most of these studies have primarily focused on Western countries, with limited representation from low- to middle-income countries. In terms of publication, many articles were found in digital health journals, with notable representation in journals such as "Journal of Telemedicine and Telecare," which publishes the most in this field. In future studies, there is a need to explore the co-creation of telehealth platforms for rehabilitation and preventive healthcare among older adults, as it has the potential to engage a larger number of individuals in this age group.

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Narrative Review on Radiation Exposure in Healthcare Workers: Unveiling the Risks and Safety Measures

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Abstract:

Introduction: The use of ionizing radiation in medical imaging and therapeutic procedures has witnessed a significant rise in recent years. This, however, has led to an increased risk of radiation exposure for both patients and healthcare providers. The cumulative exposure received by healthcare workers in clinical settings has been a major cause of concern. While limited studies have provided a narrative review of the health effects of radiation on radiation workers, this study aims to provide a comprehensive narrative review of the effects of radiation exposure specifically on healthcare workers. It includes potential short and long-term risks and measures for minimizing exposure. **Methods:** An unstructured literature review in which the original articles were screened during the period from January to April 2023, using the following sources: PubMed, Springer Link, TheBMJ, Oxford Journal, Scopus, Science Direct, Google Scholar. The screening process was limited to articles written in English and aimed to identify studies that examine the health effects of radiation among healthcare workers in clinical settings. **Results:** In total, 30 articles were identified, and 15 were selected. Various factors in relation to the health effects of radiation have been discussed. Mitigating measures are presented at the end of this article. **Conclusion:** Understanding the potential health effects of exposure, especially among radiation workers, is crucial. Therefore, it is recommended to tailor targeted preventive interventions to reduce harmful exposure to ionizing radiation and potential health issues due to ionizing radiation.

Keywords: Ionizing radiation, clinical setting, health effects, healthcare workers

Introduction:

The discovery of X-rays in the year 1895 provided the much-desired non-invasive technique of unmasking the internal structures of human anatomy. Theoretically, radiation is divided into two forms: ionizing radiation (IR) and non-ionizing radiation (NIR). IR refers to radiation with high energy that can remove electrons from atoms and cause disruptions in chemical bonds, which may possibly lead to deoxyribonucleic acid (DNA) strand breaks, mutations, and, importantly, raise concerns about its genotoxic and carcinogenic effects. (Jerome Nriagu, 2019). IR, which includes alpha and beta particles and some electromagnetic radiation (gamma and x-rays), can directly or indirectly alter the normal structure of a living cell. Meanwhile, NIR is low-frequency radiation that disperses energy through heat and increases molecular movement, such as ultraviolet rays, visible light, infrared rays, and radio waves (Bahrami Asl et al., 2023).

The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) has named X-rays as the most widely used radiation in medicine (Charles, 2001). According to the World Health Organization (WHO), in 2022, the most found artificial sources of radiation in clinical settings are diagnostic and radiotherapy. In 2008, more than 3,600 million X-ray examinations, 37 million nuclear medicine procedures and 7.5 million radiotherapy treatments were reported worldwide (Buls, 2016).

The use of IR in medical applications, such as imaging techniques, is crucial for early disease diagnosis, treatment planning, and patient monitoring. Medical professionals widely use IR to create images through various techniques, including computed tomography, fluoroscopy, dual-energy X-ray absorptiometry, mammography, and linear accelerator (Faraj, 2021). Due to the increasing number of IR sources being installed in clinical settings, this technology is expanding to other departments, such as the emergency department, operating theatres, orthopaedics, dental, and cardiac laboratories. Consequently, people who work directly with medical equipment are exposed to IR more frequently.

According to the Department of Statistics Malaysia (DOSM) report in 2022, there were 21,534 cases of occupational injuries in 2021 with 7 cases reported due to radiation. However, in 2022, 30% of cases that included lung disease, skin conditions, and hearing loss were reported due to occupational injuries. Of these cases, 0.04% were related to cancer, indicating an increase from 0.01% in 2021 (Jabatan Keselamatan Dan Kesihatan Pekerjaan, 2022).

This warrants for a comprehensive understanding of radiation in clinical settings. The objective of this paper is to provide a comprehensive narrative review of the effects of radiation exposure on healthcare workers. In addition, the mitigation measures for minimizing exposure will be discussed in this paper.

Materials and Methods:

The narrative literature review was conducted from January to April 2023 where the original articles were screened using the following sources: PubMed, Springer Link, TheBMJ, Oxford Journal, Scopus, Science Direct, Google Scholar. Several combination keywords were used, including "radiation", "health workers", "occupational health", "occupational exposure", "clinical settings", and "medical staff". Search results were enhanced by combining terms with the Boolean operators; AND, OR and NOT.

This study used specific inclusion and exclusion criteria to identify the most relevant articles that met the specific requirements as listed in Table 1. The most specific criteria was to match the objective of this paper, written in English and published between 2013 till present. This is to ensure that this paper captures the recent advancements, changes in regulation or guidelines and current trends in research related to radiation safety and healthcare worker exposure. Exclusion criteria were used to filter out unrelated or irrelevant articles to ensure that only related articles will be addressed and to limit the number of articles to review.

Table 1. Inclusion and exclusion criteria for article selection

Inclusion criteria	Exclusion criteria
Articles published between 2013-2023	Articles published before 2013
Articles related to the staff health	Articles discussing on the patient health
Full articles and free access	Abstract and limited access
Articles written in English	Articles written in languages other than English

Figure 1 describes literature selection process for the articles. In total, 30 articles were identified and 15 were selected for reviewing. The information obtained from the articles was structured and combined to create a summary that outlines the present status of scientific knowledge. The findings of this review were then utilized to identify effect of radiation and suggestions to address the issue.

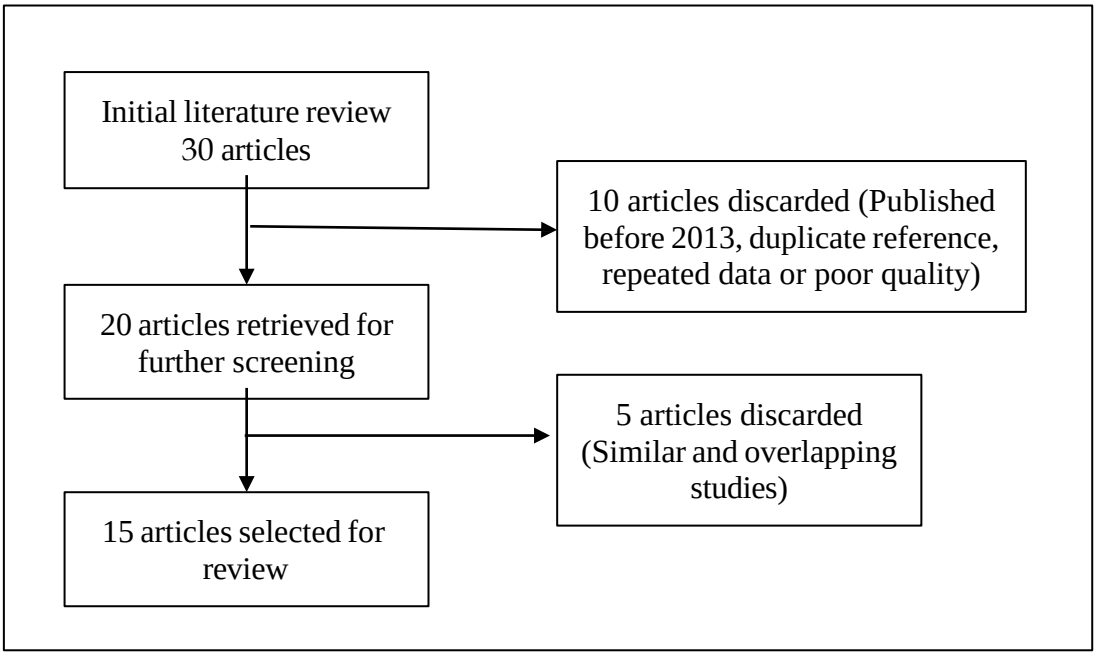

Figure 1. Flowchart of article selection process.

Results:

Biological effects caused by radiation

The consequence of the interaction of radiation with the atom of a living cell is the basis of biological effects. The interaction of radiation with biological cells could take place directly and indirectly. The direct interaction occurs when radiation interacts with the atoms of the DNA molecules or the cellular components that are critical to the survival of the cell.

When a biological cell is exposed to radiation, the probability that the radiation would have a direct interaction with the DNA molecules is very small because the DNA molecules occupy only a small portion of the cell. The component of each biological cell is mostly water. For this reason, the probability of radiation interacting with the water that makes up the cell's volume is higher. Thus, the indirect interaction of radiation occurs when radiation interacts with water molecules of a cell and other events follow.

When radiation interacts with water molecules, it could break the bond that holds the water molecules together, producing fragments such as hydrogen and hydroxyls. These fragments may combine with other ions to form compounds which would not harm the cell. They could also combine to form toxic substances, such as hydrogen peroxide, which could destroy the cell. About two-thirds of the biological damage caused by low-energy radiations, such as X-rays, is due to these indirect interactions while one-third is due to direct interaction. The biological effect of ionizing radiation is classified into two main classes, namely stochastic and deterministic effects.

Short-term Effects Towards Healthcare Worker

Occupational Safety & Health Administration (OSHA) explains in its article on Safety and Health Topics; that deterministic health effects occur when some part of the body is exposed to a radiation dose which exceeds the threshold for the respective health effect. Some of these health effects may develop after a short delay of one to four weeks of irradiation. In most controlled occupational settings, such as clinical settings, the radiation dose exposure that may result in such effects on healthcare workers is less likely. However, according to a fact sheet on IR health effects and protective measures by the World Health Organization (WHO), in scenarios like radiological emergencies, individuals who are at greater risk of

being exposed to radiation doses are high enough to cause acute effects, especially first responders and the workers of the affected facility in comparison to the general population.

Acute Radiation Sickness

Acute Radiation Syndrome (ARS) is also known as radiation toxicity or radiation sickness. Centers for Disease Control and Prevention (CDC) defines ARS in its Radiation Emergencies fact sheet as "an acute illness caused by irradiation of the entire or most of the body by a high dose of penetrating radiation in a very short period of time, usually in a matter of minutes". This syndrome is hugely due to the depletion of immature parenchymal stem cells in specific tissues. There are a few required conditions to establish ARS, which are a large dose of radiation greater than 0.7 Gy or 70 rads, an external source of radiation and high penetrating radiation that is capable of penetrating up to internal organs, involving the entire body and, finally, delivered in a short time. According to (Mario López & Margarita Martín, 2011), the progression of ARS is through three phases in which the onset, duration of the phases and dominant syndrome manifestation are proportionate to the radiation dose. It includes post-exposure from 0 to 2 days, post-exposure from 21 to 60 days and the recovery phase.

Long-term Effects Towards Healthcare Worker

Stochastic effects have a certain probability that is directly proportional to the dose. There are various late effects, occurring 90 days or more after irradiation. Therefore, it can be very difficult to determine whether stochastic effects contribute to the development of diseases such as tumours and hereditary disorders, especially on healthcare workers.

Chronic Radiation Syndrome

In stochastics, the body's water management is disrupted. As the immunity of the body decreases, secondary infections invade the organism. Doses above 10 Gy contribute to the formation of intestinal syndromes, which are characterized by reduced appetite, diarrhoea, dehydration, drowsiness, and fever. A significantly reduced number of white blood cells is also observed. All these symptoms can cause death within a few days. Doses above 50 Gy contribute to the development of cerebrovascular syndrome that manifests in a series of disorders including coordination of movements and balance, apathy and agitation, tetanic spasm, diarrhoea, seizures, and coma after a few hours.

Studies have emphasized the importance of complete blood count (CBC) in the evaluation of radiation effects on the body, especially among radiographers, which can play an important role in the prognosis and diagnosis of complications such as chronic radiation injury. Studies have proven the effect of radiation in decreasing the number of white blood cells; lymphocytes, and monocytes in radiology technologies (DavudianTalab et al., 2018). In another study, chronic exposure to low X-ray doses in healthcare workers who are exposed to radiation may significantly change the values of ALT, AST, MDA, total protein, albumin, globulin and GSH in comparison to the control group (Faraj, 2021). Thus, in Malaysia, a routine full medical check-up, including CBC, is compulsory for each radiation healthcare worker to prevent any possible events in future.

In another study, evidence shows that the frequency of chromosomal damage in radiation healthcare workers was higher than in normal individuals (Buls, 2016). At the same time elevated levels of reactive oxygen species (ROS), oxidative DNA damage and immunosuppression may be triggered by irradiation. Exposure to IR can change the numbers and functions of immune system cells and cause an inflammatory response, which activates various pro-survival pathways and factors such as nuclear factor kappa B and members of signal transducers and activators of transcription (STATs) (Bolbol et al., 2021).

Cancer risk

Healthcare professionals' cumulative lifetime occupational radiation dosage and any potential negative effects have been a source of concern for decades. There has been a clear link between radiation exposure and cancer incidence among healthcare workers. Historically, radiology was known as the cause of the first incidence of skin cancer (Rajaraman et al., 2016). Lee WJ et al. (2018) conducted a study in South Korea to calculate the lifetime risk of malignancies brought on by occupational radiation exposure among radiologists and medical radiographers (Lee et al., 2018).

Consequently, the higher lifetime attributable risks (LAR) among women was significant mainly to breast and thyroid cancer risks. Meanwhile, men's LAR were higher in other cancer sites with colon cancer being the highest. In addition, a 14-years cohort study was done among 90,957 radiologic technologists in regards to

involvement in fluoroscopically guided interventional procedures (FGIP) in which the analysis showed an approximately two fold increased risk of brain cancer mortality and significant risk in incidence of breast cancer and melanoma (Rajaraman et al., 2016). This high risk may possibly be due to lack of shielding applied during the intervention procedure.

Stochastic effects are also responsible for changes in reproductive cells that may contribute to generating mutations in offspring. However, acknowledgement of the presence of unmeasured confounding by non-radiation risk factors may possibly affect the results as well. In contrast, Kitahara et al (2017) revealed that death from malignant intracranial tumours was not related to cumulative occupational radiation exposure to the brain . The cancer risk due to IR exposure to healthcare workers has to be explored in more detail.

Mitigation Measures

Healthcare workers encounter different health risks in clinical settings due to their exposure to diagnostic ionizing radiation. While the level of exposure is within acceptable limits, being exposed to ionizing radiation still poses potential hazards that can lead to many diseases and unfavourable outcomes as stated in the previous discussion. Due to this, many preventive measures have been taken by the authorities and the systems of each working place, including applying basic radiation protection principles, including distance, time and shielding actions (Bolbol et al., 2021).

Even though authorities have taken many safeguards, the knowledge and practice of the healthcare workers themselves have to be taken into consideration to minimize these risks. In 2020, a cross-sectional study was carried out at the Diagnostic Radiology Department of Zagazig University Hospital, revealing that a plurality of healthcare workers demonstrated a strong awareness of occupational health and safety measures, exhibiting excellent knowledge and adherence to radiation hazard protocols. These include wearing a Thermoluminescent Dosimeter (TLD), lead apron, lead goggles, thyroid collar, and gonad shield on daily work, as well as checking if there are any cracks before wearing. Additionally, it emphasizes strictly prohibited consumption of food and beverages in work areas, and a significant proportion of healthcare workers possess sufficient knowledge regarding exposure doses and utilize various periodic examinations to monitor their exposure levels (Fathy Zaitoun et al., 2021).

By virtue of this matter, all healthcare workers, including those who regularly spend significant amounts of time in radiation environments, necessitate comprehensive monitoring protocols, including job-specific education, training, and the provision of appropriate protective tools and equipment (Miller et al., 2010). On top of that, regular medical examinations of healthcare workers exposed to ionizing radiation are crucial to ensure compliance with safety regulations. These examinations help mitigate the risks associated with developing hazards caused by ionizing radiation. Furthermore, conducting long-term epidemiological surveillance of these workers enables authorities to estimate the potential long-term effects of low-dose radiation exposure (Baudin et al., 2023).

It is recommended to utilize radiation protection tools, hold training courses and follow up the technicians to reduce the effect of radiation on these individuals (Faraj, 2021). Although the accumulation dose in radiation workers was lower than the dose limits, it should be noted that long term exposure to ionizing radiation under defined dose limits can have adverse health effects. This highlights the crucial role of monitoring radiation workers as an at risk population.

Discussion:

In general, this comprehensive overview of the biological effect of radiation on healthcare workers focuses on both short and long-term consequences. It addresses the direct and indirect interactions of radiation with living cells, leading to deterministic effects like ARS and stochastic effects such as cancer and hereditary disorders. It also revealed that chronic exposure to low X-rays in healthcare workers who are exposed to radiation might significantly change the value of ALT, AST, MDA, total protein, albumin, globulin and SGH. Thus, the reviews emphasizes significant risks faced by healthcare workers, especially in scenarios like radiological emergencies.

This paper covers a wide range of topics and is not limited to the effect of radiation but also provides insights into mitigation measures employed. However, while this paper covers the two focus areas, it could benefit other papers in the future by covering a broad spectrum of information, including exact radiation exposure levels associated with different effects. In addition, the review focuses primarily on healthcare workers, which is relevant but may not fully encompass all aspects of radiation exposure and its effects.

In addition, one notable gap that the authors encountered is the lack of discussion on the psychological and emotional impact of radiation exposure on healthcare workers. This includes stress, anxiety and burnout which are increasingly recognized as important factors in occupational health. It is recommended that future studies focus on long-term follow-ups with healthcare workers to better understand the cumulative effects of radiation exposure over time. Comparative studies between different types of healthcare settings, such as hospitals, clinics, and research facilities, could provide insights into varying levels of exposure and risk. Plus, there seems to be a lack of clarity in the standard operating procedure for healthcare staff who have been diagnosed with occupational hazards related to radiation exposure. As a result, it is recommended to establish a proper protocol that can effectively safeguard the health and well-being of the healthcare workers both directly and indirectly.

Conclusion:

It is widely recognized that healthcare workers in clinical settings are at a heightened risk of exposure to radiation, which can have severe impacts on their health and well-being, especially after long-term exposure. From direct interactions with DNA molecules to indirect effects through water molecules in cells, the review outlines the various ways radiation can damage living tissues. As it is proven that exposure to radiation can significantly affect the health status of healthcare workers, an improvement can be made by the local authorities in terms of guidelines and protocols, training programs and occupational safety. In addition, healthcare workers should play an important role in ensuring a safe and healthy environment at their workplace by applying the principle of radiation protection endorsed by the local and international authority.

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Prevalence and Factors Influencing Biofilm-producing Bacteria on the Toothbrushes of Health Sciences Undergraduate Students

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Abstract:

Introduction: Biofilm is the formation of microorganisms that adhere to surfaces, producing a matrix that makes them resistant to harsh conditions such as antimicrobial therapies. This resistance can result in prolonged and challenging infection treatment. Common items like toothbrushes can harbour microbes that produce biofilm, thus contributing to adverse effects for the users. However, the factors that might interplay with the occurrence of biofilm on toothbrushes are scarce. Hence, this study aimed to understand the prevalence and potential causes of biofilm-producing bacterial contamination of toothbrushes among undergraduate students of a health sciences campus. **Methodology:** The study included 36 respondents, selected through convenience sampling. Each respondent completed a questionnaire that addressed demographic information, toothbrush characteristics, and oral hygiene practices. Their toothbrushes were tested by soaking the bristles in distilled water for 30 minutes, and then cultivating the water on Congo Red Agar plates. **Results:** Biofilm-producing bacteria were identified by the black and dry colony growth on the plates. Bacterial growth was observed on all toothbrushes, with five identified as biofilm producers. The study found no significant association (p>0.05) between toothbrush characteristics or oral hygiene practices and the presence of biofilm-producing bacteria on the toothbrushes. **Conclusion:** The findings suggest that toothbrushes can harbour bacterial growth, indicating the need for further research to understand the potential health implications.

Keywords: Biofilm, toothbrush, hygienic practices

Introduction:

Biofilms are complex communities of microorganisms that are ubiquitous and can develop in diverse environments, from natural habitats like ant bodies (Actinobacteria) to industrial areas like ship

hulls (Lo'pez, et al. 2010). In medical settings, they can adhere to devices like catheters and stents, with growth rates varying based on device type and implantation duration (Su, et al. 2022). The formation of biofilms poses challenges in health management due to their ability to trigger various diseases. Susewind, et al. (2015) observed that biofilm formation on oral equipment like dentures could harbour *Candida albicans*, leading to oral health complications and systemic diseases. Additionally, orthodontic appliances can exacerbate biofilm growth, resulting in tooth decay and white spot lesions (WSLs) (Ren et al. 2014). Furthermore, their resilience against various threats including host defenses, environmental stresses, and notably antibiotics, elevates concerns about biofilm-related infections in healthcare communities. Their ability to withstand antibiotics is particularly alarming, with their tolerance potentially increasing by 10-1000 times compared to planktonic cells (Rumbaugh and Sauer, 2020).

While extensive data exists regarding bacterial contamination on common everyday items, such as toothbrushes, limited studies focus on the detection of biofilm producers among these contaminants (Karibasappa et al., 2011; Saini and Kulkarni, 2013; Asumang et al., 2019). Moreover, there is a lack of accessible studies focusing on the population of health science students, who could serve as key advocates for promoting awareness of oral hygiene within the broader community. Therefore, the present study aims to detect biofilm-producing microorganisms, highlighting their potential to establish resilient communities on toothbrush surfaces among health science undergraduate students. In addition to detecting their presence, another crucial aspect to emphasize is the factors that influence their establishment. As reported by Chao et al. (2014), host-bacteria interactions such as quorum sensing, and environmental factors such as nutrient availability, pH, and temperature, heavily influence biofilm activities. By understanding the behavior of these biofilm producers concerning other influencing factors, the present study sought to determine the possible association between biofilm producers and toothbrush characteristics, as well as host oral hygiene practices.

Methodology:

Ethical Approval

The study received ethical clearance from the Kulliyyah of Allied Health Sciences Postgraduate and Research Committee (KPGRC) International Islamic University Malaysia (IIUM) Research Ethics Communities (IREC) (IREC 2023-KAHS/DBMS12). The participant's personal information was kept private at all times.

Questionnaires Preparation and Distribution

The survey employed in this study adapted and modified questionnaires used in previous studies by Khamuani, et al., (2018) and Nadar, et al. (2021). The questionnaire consisted of three parts: Part 1 was about participants' consent and demographic details including gender, program, and year of study, Part 2 focused on toothbrush characteristics, such as type and material; and Part 3 addressed oral hygiene practices, including brushing frequency and duration, toothbrush storage, and the use of other oral care products. The questionnaire was distributed to participants who volunteered and met the inclusion criteria, which included being active undergraduate students who had a used toothbrush. Recruitment efforts utilized verbal and written messages, as well as through online channels such as social media. Those who agreed to participate received additional face-to-face clarification from the researchers. Each participant was assigned a code to replace the real name to ensure the confidentiality of their data. A similar coding system was employed for toothbrush analysis.

Preparation of Congo Red Agar plate

Congo Red Agar (CRA) is a specialized agar medium used to selectively isolate and differentiate bacteria based on their capability to produce extracellular polysaccharides, particularly those involved in biofilm formation. The interaction of red dye in the agar with the compound of the extracellular polymeric substances (EPS) or its intermediate changes the red colour to dark red or black, which can be easily observed in the colony growth on the agar (Rajkumar et al., 2016). The agar was prepared by mixing 47g of Brain Infusion Heart, 5g of glucose, 10g of Technical Agar No. 2, and 0.8g of Congo Red Dye with 1L of distilled water before autoclaving at 121°C for 15 minutes (Bose et al., 2009). The poured into plates to solidify. The solidified plates were then incubated overnight to inspect for contamination. The agar plates were stored at 2 - 8°C before use.

Sampling and Biofilm Detection

A total of 36 toothbrushes were collected from participants and transported to the lab in a sterile pouch. The bristles of each toothbrush were immersed in sterile distilled water for 30 minutes. Subsequently, the water was thoroughly swirled before transferring one loopful onto Congo Red Agar (CRA) plates for culturing. These plates were then incubated at 37°C

for 24 - 48 hours under aerobic conditions. Any growth of bacterial colonies was recorded, with the presence of black colonies indicating biofilm producers. Alongside the experimental samples, *Streptococcus mutans*, a biofilm-producing clinical strain obtained from another biofilm-unpublished study, was cultivated as a positive control. Agar plates without bacterial culture was incubated together to ensure the sterility of the plates.

Statistical Analysis

The occurrence of biofilm-producing bacteria in the samples was analysed using descriptive analysis. Meanwhile, the association between these bacteria and variables like demographic data, toothbrush characteristics, and oral hygiene habits was assessed using the Chi-square test. A *p*-value less than 0.05 was considered statistically significant.

Results:

Demographic data of participants

Out of the 36 toothbrushes collected from the undergraduate students, the majority, 31 (86.11%), belonged to females while five (13.89%) belonged to the male respondents. A significant portion, 28 students (77.78%), were in their third year, with only one student (5.56%) from the second year and five students (13.89%) in their fourth year. The majority of respondents were enrolled in the allied health sciences program (32, 88.89%) while the remainder were from the medical, dentistry, and science-based programs. None of the respondents were smokers.

Biofilm-producing bacteria on toothbrushes

Upon completing the laboratory analysis, all toothbrushes revealed the presence of bacterial growth, five of which were identified as biofilm producers. The count and percentage of toothbrush samples positive for biofilm-producers are illustrated in Figure 1. Black colonies on the plates signified positive results for biofilm-producing bacteria (Figure 2).

Distribution of biofilm-producing bacteria and its association with evaluated variables

Regarding the material of the bristles, 28 students (77.78%) used non-charcoal bristles, while eight students (22.22%) used charcoal bristles. Two toothbrushes with charcoal bristles and three with non-charcoal bristles were found to be harboured by biofilm-producing bacteria, accounting for 25% and 10.7% respectively. Intriguingly, the majority of biofilm producing bacteria were found on the soft bristle samples (four out of five bacteria) equating to 25% of the total of 16 soft bristle toothbrushes. While one biofilm producer was detected on a medium bristle toothbrush, none were found on the hard bristles. Nevertheless, none of these distributions were significantly different (Table 1).

In terms of toothbrush usage duration, 11 students (30.56%) had used their toothbrushes for three months. Five students (13.89%) reported usage for one month, and another five for less than a month (13.89%). Three students (8.33%) had been using their toothbrushes for over four months, and two students (5.56%) for exactly four months. Biofilm-producing bacteria was detected on a toothbrush with one-month usage and on two toothbrushes each from the two and three-month usage categories. However, this distribution did not show any significant variance (Table 1).

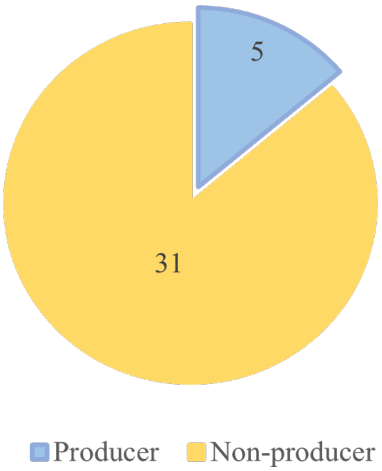

Figure 1: Occurrence of biofilm producing bacteria on toothbrushes. Total number of samples, n=36.

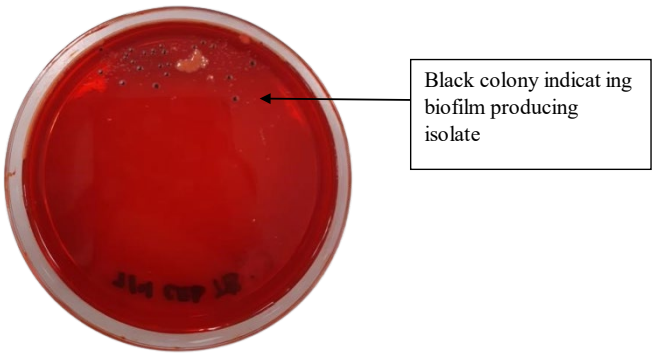

Figure 2: Black colony on Congo Red Agar plate indicating biofilm producing bacteria.

Table 1: Distribution of biofilm-producing bacteria and its association analysis with the variables

Variable	Isolated bacteria, N (%)		x^2 (df)	*p*-value
	Biofilm producer	Non-biofilm producer		
Bristle materials				
Charcoal	2 (25)	6 (75)	0.000 (5)	1.000
Non-charcoal	3 (10.7)	25 (89.3)		
Type of toothbrush				
Soft bristle	4 (25)	12 (75)	2.919 (3)	0.529
Medium bristle	1 (6.2)	15 (93.8)		
Hard bristle	0 (0)	1 (100)		
Unknown	0 (0)	3 (100)		
Toothbrush usage duration				
<1 month	0 (0)	4 (100)	2.842 (3)	0.562
1 month	1 (20.0)	4 (80)		
2 months	2 (18.2)	9 (81.8)		
3 months	2 (18.2)	9 (81.8)		
4 moths	0 (0)	2 (100)		
> 4 months	0 (0)	3 (100)		
Brushing duration				
<1 minute	0 (0)	2 (100)	2.842 (3)	0.562
1 minute	2 (9.1)	20 (90.9)		
2-5 minutes	3 (27.3)	8 (72.7)		
>5 minutes	0 (0)	1 (100)		
Brushing frequency in a day				
Once a day	0 (0)	2 (100)	1.699 (2)	0.549
Twice a day	4 (12.9)	27 (87.1)		
>Twice a day	1 (66.7)	2 (33.3)		
Type of toothpaste				
Fluoride	4 (1.54)	22 (84.6)	0.416 (2)	1.000
Fluoride-free	0 (0)	3 (100)		
Unknown	1 (14.3)	6 (85.7)		
Use of mouthwash				
Yes	0 (0)	7 (100)	0.000 (1)	0.559
No	5 (17.2)	24 (82.8)		
Toothbrush storage				
Bedroom	4 (15.4)	22 (84.6)	2.834 (5)	1.000
Toilet	1 (16.7)	5 (83.3)		
Other	0 (0)	4 (100)		

N=number of participants

A majority of respondents, 22 (61.11%), spent approximately one minute brushing their teeth. Next, 13 participants (30.56%) took between two to five minutes, while a single respondent (2.78%) brushed for more than five minutes. In terms of daily brushing frequency, the prevalent habit was twice a day (86.11%). Only two participants (5.56%) reported brushing once daily, and a few, 8.33%, brushed more than twice. Furthermore, 23 participants opted to replace their toothbrush quarterly, whereas eight changed it once a year (22.22%). The presence of biofilm-producing bacteria on toothbrushes varied based on brushing duration, with two brushes from the one-minute group and three from the 2 - 5 minute group. Moreover, four out of the five biofilm producers were found on brushes that were used twice daily (Table 1).

As for toothpaste preferences, 26 participants (72.22%) used fluoride toothpaste, and just three (8.33%) opted for fluoride-free variants. In the field of additional oral care, 29 participants (80.56%) did not use mouthwash. Interestingly, toothbrushes that used fluoridated toothpaste harbored four out of the five biofilm-producing bacteria. Furthermore, when considering the factor of mouthwash usage, all five-biofilm producers were detected on the toothbrushes of individuals who did not practice the use of mouthwash (Table 1).

In relation to toothbrush storage, the bedroom was the primary location for 26 participants (72.22%), where four biofilm producers were detected from toothbrushes which were kept in this space. Six (16.67%) stored their toothbrushes in the bathroom, while the rest had alternative storage spots. Yet, no significant association was identified for this distribution (Table 1).

Discussion:

Biofilms commonly develop on clinical equipment and devices such as catheters, orthopaedic implants, dental prosthetics, and breast implants. Their presence can cause severe infections in humans and exhibit antibiotic resistance, potentially leading to reinfections and chronic inflammation. Furthermore, biofilms can form on common items used like mobile phones, doorknobs, and clothing (Dixit, et al., 2023). This situation increases the risk of getting infected by biofilm pathogens which is harder to treat with the standard antimicrobial therapies. The occurrence of biofilm producers on toothbrushes, the most common daily used tools in oral health care, increases the risk for oral-associated disease. This research revealed that toothbrushes could harbour biofilm-producing bacteria, albeit at a low number, in five out of the 36 samples (13.89%). Though the percentage is low, it still suggests that toothbrushes can be considered as conducive environments for microbial growth. This is supported by research from Saini and Kulkarni (2013) who identified that toothbrushes can be primary habitats for various microorganisms, particularly bacteria. The space between the bristles of toothbrush can trap food particles, providing nourishment for microbes and enabling them to thrive and proliferate. These findings support the hypothesis that toothbrushes can be ideal breeding grounds for bacteria.

The Chi-Square test analysis revealed no significant association between all examined variables (characteristics of toothbrushes and hygienic practices of the participant) and the presence of biofilm-producing bacteria. These findings challenge the initial hypothesis suggesting these variables as potential contributors to biofilm development on toothbrushes. For instance, with regards to charcoal bristles, AlDhawi, et al. (2020) observed that charcoal bristles show a lower colony forming unit (CFU) count on blood agar plates than non-charcoal ones. Considering the characteristics of activated charcoal, renowned for its ability to adsorb toxins and eliminate bacteria, it was predicted that toothbrushes containing charcoal infusion could harbour fewer bacteria compared to those without charcoal (Silberman, et al., 2023; Thamke, et al., 2018). This reduction in bacterial presence may result in fewer cells available to initiate biofilm formation, consequently leading to a lower quantity of detected biofilm in the examination. This justification could be supported by the *in vitro* analysis done by Panariello, et al., (2020) who reported that charcoal-based dentifrices demonstrated inhibition of *Streptococcus mutans* biofilm, albeit the reduction was not statistically significant. Since very minimal studies focus on this scope, further study is needed to clarify the exact association and mechanism that may exist.

Although this study did not identify a substantial association between the variables investigated and the formation of biofilm, there were indications of increased growth of biofilm-producing bacteria under certain circumstances. For example, toothbrushes featuring soft bristles exhibited a higher incidence of biofilm compared to those with medium or hard bristles. It could be speculated that the ability of soft bristles to retain moisture for extended periods might create an environment conducive to bacterial growth, including stages of bacterial colonization essential for biofilm development. The pliability of soft bristles may form deeper recesses and spaces where bacteria can shelter, especially if the bristles bunch up when damp. Even though these factors might directly influence bacterial growth, the propensity for biofilm formation likely depends on the level of bacterial contamination on the brush. The precise mechanisms through which soft bristles might offer an ideal surface for biofilm-forming cells to begin attachment and progress through subsequent stages remain elusive. Further studies would certainly provide a more detailed understanding.

Brushing teeth multiple times, a day appears to increase the likelihood of biofilm-producing bacteria residing on toothbrushes compared to brushing just once daily. Kim, et al. (2018) noted that toothbrushes used three times a day harboured a higher count of general bacteria and coliform than those used less frequently. This suggests that the more a toothbrush is exposed to the oral environment, the greater the transfer of oral bacteria to the brush. While frequent brushing may reduce oral bacteria, including biofilm-producing ones in the mouth, they might persist on the bristles without proper cleaning measures. However, frequency isn't the only influencing factor; brushing techniques, as highlighted by Chhaliyil, et al. (2020), can also play a role in this phenomenon.

Initially, it was hypothesized that fluoride toothpaste could diminish bacterial viability in oral biofilms (Naumova, et al., 2019). This assumption stems from the knowledge that fluoridated toothpastes that contain sodium fluoride can permeate bacterial cell membrane, thereby interrupting bacterial metabolism. Amine fluoride, another compound known for its cationic antimicrobial properties, can attach to the bacterial cellular surface, thus leading to poor integrity of the cell membrane. Such interactions could diminish bacteria transfer from the oral cavity to the toothbrush leading to decreased biofilm development. Surprisingly, our findings showed a higher presence of biofilm-producing bacteria on toothbrushes used with fluoridated toothpaste. A potential reason might be other factors at play, such as toothbrush cleaning habits. Conversely, our observation aligned with the initial assumption regarding the impact of mouthwash. Mouthwash, an oral antiseptic has been shown to reduce biofilm growing on the surface of glass and Teflon after just a 30-second rinse. The foams of mouthwash prevent colonization and cariogenic action of acid-producing bacteria (Jones, et al., 2018). Among the biofilm-producing bacteria samples in this study, none of the participants used mouthwash, indicating its potential role in reducing biofilm formation.

The storage location for toothbrushes was initially thought to influence bacterial contamination. For instance, a moist bathroom environment might boost bacterial growth due to factors like aerosol from flushing. Contrarily, four out of five biofilm-positive samples in this study were stored in bedrooms. While humid conditions can support bacterial growth (Kim, et al., 2018), Okafor (2016) suggested that storage location might not significantly affect oral health.

Students with backgrounds in health sciences, medicine, and science, particularly dentistry are well-informed about the importance of oral hygienic practices. Their knowledge may contribute to proper oral cleaning habits, including the correct use and storage of their toothbrush and toothpaste. The awareness and practice of these respondents likely resulted in lower contamination rates, highlighting the significance of education in oral hygiene

Despite the significance of the study for future healthcare, particularly in oral health, it faces a lack of participant diversity and inadequate number of toothbrush samples. This imbalance, including the gender and academic program of respondent, characteristics of toothbrush materials and other variables may affect the study's conclusions. A larger-scale study is recommended to provide a clearer understanding and more robust conclusions.

Conclusion:

In summary, the study identified the potential for biofilm formation on toothbrushes, with certain variables possibly influencing this occurrence, even if not deemed significant in this research. It is imperative to delve deeper into these potential risk factors to enhance prevention strategies in oral healthcare. Additionally, this research emphasizes the need to heighten awareness about oral hygiene practices, especially among health sciences students, to ward off potential oral health challenges in the future.

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Knowledge, Attitude & Practice Regarding Breast Cancer and Breast Self-examination (BSE) among Undergraduate Students of International Islamic University Malaysia (IIUM)

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Abstract:

Introduction: Breast cancer is one of the leading causes of global cancer mortality, due to late detection. This study aimed to determine the level of knowledge, attitude, and practice regarding breast cancer and breast self-examination among students. **Methodology:** A survey was conducted among 36 undergraduate students from International Islamic University Malaysia, Kuantan, Pahang who attended the Breast Cancer Webinar post six-month intervention using a validated questionnaire on knowledge, awareness on breast cancer, and practice of breast self-examination. The data obtained were analysed using descriptive statistics, Independent T-test, One-way ANOVA, and Pearson Correlation via SPSS version 27.0. **Results:** The mean age of the participants was 22.69 (±1.470), female (83.3%), Malay (100.0%), year 4 (61.1%), single (100.0%), with no family history of breast cancer (97.2%) and have experience in taking care of breast cancer patients (50.0%). There was a significant association between faculty of study and knowledge of risk factors ($p=0.008$) along with signs and symptoms of breast cancer ($p < 0.001$). Gender ($p<0.001$) and area of residence ($p<0.001$) were associated with awareness of breast cancer and breast self-examination. For practice domain, only gender was associated with breast self-examination ($p=0.011$). **Conclusion:** This study showed undergraduates still have moderate knowledge, attitude, and practice towards breast cancer and BSE even after the intervention. Integration of technology is required in the future awareness program.

Keywords: Breast self-examination, knowledge, awareness, practice, students, intervention

Introduction:

Breast cancer is more common among women in less developed nations (883,000 cases) than in developed regions (794,000 cases) (Goncheh et al., 2016). Furthermore, 59% of breast cancer cases occurred in developed countries (North America, Europe, Australia, New Zealand, and Japan) in 1990.

However, a change in the pattern of breast cancer incidence occurred in 2008, with new diagnoses equally divided between less developed and developed countries (Goncheh et al., 2016).

The five countries with the highest standardized incidence rate of breast cancer (per 100,000) were Israel (80.5), Lebanon (78.7), Armenia (74.1), Singapore (65.7), and Kazakhstan (73.5) (Goncheh et al., 2016). Across Southeast Asia, Singapore has the highest incidence rate of breast cancer, which continues to rise over the years (Ng et al., 2020). Conversely, the five countries in the Asian region with the highest standardized death rates (per 100,000) from breast cancer were Pakistan (25.2), Armenia (24.2), Lebanon (24.0), Jordan (21.8), and Syria (21.5) (Goncheh et al., 2016).

In Malaysia, regardless of gender, breast cancer contributed to 19.0% of all new cancer cases diagnosed in 2012–2016, compared with 17.7% in 2007–2011 (Clinical Practice Guidelines Ministry of Health Malaysia, 2019). The incidence was highest among Chinese (40.7 per 100,000), followed by Indians (38.1 per 100,000) and Malays (31.5 per 100,000) (Clinical Practice Guidelines Ministry of Health Malaysia, 2019). In terms of breast cancer survival, the 5-year relative survival rate between 2005 and 2009 in Malaysia was 67.8%. Approximately 48% of breast cancer cases in Malaysia are diagnosed late due to negative sociocultural perceptions regarding breast cancer, strong beliefs in traditional medicines and treatments, and financial problems (Clinical Practice Guidelines Ministry of Health Malaysia, 2019; Shah et al., 2020).

Therefore, early screening measures such as BSE, clinical breast examination (CBE), and mammography have the potential to reduce the burden of breast cancer caused by late presentation (Massat et al., 2016; Clinical Practice Guidelines Ministry of Health Malaysia, 2019; Shah et al., 2020; Htay et al., 2021). Although BSE is not a screening method, it is advocated to raise awareness of breast cancer and empower women to take responsibility for their own health (Clinical Practice Guidelines Ministry of Health Malaysia, 2019). Mammography is the best method for early detection of breast cancer; however, in most developing countries, mammography is expensive and inaccessible. Hence, breast self-examination is the most practical and cheapest way (Fondjo et al., 2018).

Furthermore, there are limited studies on measuring the impact of knowledge, attitude, and practice among university students after certain health education programs. Previous studies in local settings were conducted among nurses (Siti Noorkhairina et al., 2020; Siti Noorkhairina & Fadhlin Farhanah, 2023), the general population (Akhtari-Zavare et al., 2016), and private college students (Yong & Soon, 2017; Ali et al., 2019). Thus, the present study aims to investigate the knowledge, attitude, and practice regarding breast cancer and breast self-examination among undergraduate students at the International Islamic University Malaysia (IIUM) Kuantan, Pahang, six months post-breast cancer awareness program.

Methodology:

Participants

A quasi-intervention study for a single arm (post) was conducted between June and July 2022 among 36 students after they participated in a one-day "Breast Cancer Webinar" organized by the students of NURF 4314 Discovery of Specialization: Continuous Nursing Education, Kulliyyah of Nursing, IIUM Kuantan, six months ago. The study was approved by the Kulliyyah of Nursing Postgraduate Research Committee (KNPGRC) No. 1/2022 dated 1st March 2022 and IIUM Research Committee (IREC 2002-KON/60).

Settings

Students were conveniently recruited from IIUM Kuantan Campus only.

Measures

A previously validated instrument, namely the Knowledge Awareness and Practice Test regarding Breast Cancer, was adopted with modifications after permission was obtained from the original author (Siti Noorkhairina et al., 2020). The final version of the questionnaire consisted of five parts. Part A is on sociodemographic data; Part B has 17 items that measured risk factors, while Part C has 10 items that assessed the knowledge of signs and symptoms with a dichotomous choice of 'yes' or 'no'. Meanwhile, 10 items in Part D measured the awareness of BSE, and Part E described the practice of BSE on an extreme end 10-point Likert scale ranging from 0 points for strongly disagree to 10 points for strongly agree. Five nursing experts were invited to validate the questionnaire. The content validity index (CVI) obtained was 99% with a strong internal consistency of r2 = 0.885, which was piloted among 30 nursing students. The students involved in the pilot study were not recruited for the actual study.

Data Analysis

The IBM Statistical Package for Social Sciences (SPSS) software version 27.0 was used for descriptive analysis. Mean and standard deviation were reported for numerical data, while frequency and percentage represented categorical data. The Independent T-test, One-way ANOVA, and Pearson Correlation were used to determine the association between socio-demographic background and knowledge, attitude, and practice towards breast cancer and BSE. Statistical significance was accepted at $p < 0.05$.

Results:

Socio-demographic Background

Table 1 shows the socio-demographics of the students. The mean age of the students in this study was 22.69 (± 1.47) years, with 83.3% being female, 100.0% Malay, studying in the Kulliyyah of Nursing (69.4%), and staying at Mahallah Ummu Kalthum (52.8%).

Table 1: Sociodemographic background of students (n=36)

Variable		Frequency (n)	Percentage (%)	Mean (SD)
Age				22.69 (±1.470)
Gender	Male	6	16.7	
	Female	30	83.3	
Race	Malay	36	100.0	
Kulliyyah (Faculty)	Kulliyyah of Nursing	25	69.4	
	Kulliyyah of Allied Health Science	2	5.6	
	Kulliyyah of Dentistry	2	5.6	
	Kulliyyah of Medicine	6	16.7	
	Kulliyyah of Sciences	1	2.8	
Year	Year 1	3	8.3	
	Year 2	8	22.2	
	Year 3	3	8.3	
	Year 4	22	61.1	
Residency area	Living off campus	8	22.2	
	Living on campus			
	a) Mahallah Ummu Khaltum	19	52.8	
	b) Mahallah Khalid Al-Walid	5	13.9	
	c) Mahallah Fatimah Az-Zahra	4	11.1	
Marital status	Single	36	100.0	
Family history	Yes	1	2.8	
	No	35	97.2	
Experience taking care of breast cancer patients	Yes	18	50.0	
	No	18	50.0	

Knowledge of the Risk Factors of Breast Cancer

Most of the students know that breast cancer risk increases with age (97.2%) and smoking habits (94.4%) (Table 2). The mean score is 12.97 (±2.591), which is lower than the 50th percentile score (14.00), indicating moderate knowledge (Siti Noorkhairina et al., 2020; Siti Noorkhairina & Fadhlin Farhanah, 2023).

Table 2: Knowledge regarding risk factors of breast cancer answered correctly (n=36)

No.	Items	Answer	Frequency (n)	Percentage (%)
1.	Breast cancer risk increases with age	Yes	35	97.2
2.	Breast cancer is inherited disease	Yes	32	88.9
3.	A high-fat diet is a risk factor for breast cancer	Yes	25	69.4
4.	Smoking is a risk factor for breast cancer	Yes	34	94.4
5.	Alcohol consumption increases the risk for breast cancer	Yes	31	86.1
6.	Pregnancy at age of more than 30 years old increases the risk for breast cancer	Yes	26	72.2
7.	Early menarche below 11 years old increases the risk for breast cancer	Yes	23	63.9
8.	Late menopause is a risk factor for breast cancer	Yes	22	61.1
9.	Stress increases the risk for breast cancer	Yes	29	80.6
10.	Obesity is one of the risk factors for breast cancer	Yes	30	83.3
11.	Women who have never conceive (*nulliparous*) is at risk for breast cancer	Yes	29	80.6
12.	The use of contraceptive pills increases the risk for breast cancer	Yes	20	55.6
13.	Breastfeeding decreases the risk for breast cancer	Yes	34	94.4
14.	A high level of estrogen hormone increases the risk for breast cancer	Yes	27	75.0
15.	Breast cancer is one type of contagious disease	Yes	3	8.3
16.	Breast cancer has no cure	Yes	11	30.6
17.	Late detection of breast cancer can cause death	Yes	34	94.4

Knowledge on the Signs and Symptoms of Breast Cancer

Almost 97.2% recognized that a lump in the breast and armpits, along with pain, soreness, and swelling or enlargement of the breasts, were signs and symptoms of breast cancer (Table 3). The mean score is 10.22 (±1.692), which is lower than the 50th percentile score (11.00), indicating moderate knowledge (Siti Noorkhairina et al., 2020; Siti Noorkhairina & Fadhlin Farhanah, 2023).

Awareness of Breast Cancer and its Screening Method (BSE)

The mean score of the awareness level was 85.94 (±11.074), which is lower than the 50th percentile score (89.50), indicating moderate awareness of BSE (Siti Noorkhairina et al., 2020; Siti Noorkhairina & Fadhlin Farhanah, 2023). Table 4 shows that only 27.8% of the students could perform BSE correctly, and 47.2% could not.

Practice of BSE
The mean practice score is 26.53 (±8.529), which is lower than the 50th percentile score (30.00), indicating low practice levels of BSE (Siti Noorkhairina et al., 2020; Siti Noorkhairina & Fadhlin Farhanah, 2023).

Associations between Sociodemographic Factors and Knowledge, Awareness, and Practice
The knowledge domain demonstrated that the Faculty of Study was significantly associated with risk factors ($p=0.008$) along with signs and symptoms of breast cancer ($p<0.001$) (Table 5). Gender ($p<0.001$) and area of residence ($p<0.001$) were associated with awareness of breast cancer and breast self-examination. Only gender ($p=0.011$) was associated with the practice of breast self-examination.

Discussion:

The present study assessed the knowledge, attitude, and practice (KAP) regarding breast cancer and breast self-examination (BSE) among undergraduate students at the International Islamic University Malaysia (IIUM) Kuantan, six months post a breast cancer awareness webinar. The findings indicate that students maintain moderate levels of knowledge and awareness but exhibit low practice levels of BSE, underscoring the need for enhanced educational interventions.

Knowledge of Risk Factors and Signs/Symptoms
The study reveals that while students are aware of common risk factors and signs/symptoms of breast cancer, their knowledge remains moderate, with mean scores falling below the 50th percentile. This is consistent with previous findings by Siti Noorkhairina et al. (2020) and Siti Noorkhairina and Fadhlin Farhanah (2023), suggesting a persistent gap in comprehensive understanding. The significant association between faculty of study and knowledge of risk factors and signs/symptoms ($p=0.008$ and $p<0.001$, respectively) highlights the role of educational background in shaping awareness levels. This aligns with Abdullah et al. (2020), who reported similar associations in different academic settings.

Table 3: Knowledge regarding sign and symptoms of breast cancer answered correctly (n=36)

No.	Items	Answer	Frequency (n)	Percentage (%)
1.	A lump at the area of the breast is a sign of breast cancer	Yes	35	97.2
2.	A nipple discharge indicates the sign of breast cancer	Yes	34	94.4
3.	Pain and soreness in the breast are signs and symptoms of breast cancer	Yes	35	97.2
4.	Changes in the size of one or both breasts indicate a sign of breast cancer	Yes	33	91.7
5.	Breast skin ulceration is one of the breast cancer signs	Yes	33	91.7
6.	A breast cancer patient usually experiences weight loss	Yes	32	88.9
7.	Changes in the shape of one or both breasts indicate a sign of breast cancer	Yes	33	91.7
8.	An inverted nipple in one or both breasts is a sign of breast cancer	Yes	29	80.6
9.	Breast cancer will cause swelling and enlargement of the breast	Yes	35	97.2
10.	Lumps under the armpit is a sign of breast cancer	Yes	35	97.2
11.	*Peau d'orange* skin at the breast area is a sign of breast cancer	Yes	34	94.4

Table 4: Association between sociodemographic factors and knowledge towards risk factors of breast cancer among undergraduates in IIUM (n=36)

Characteristic	Variables	n	Mean (SD)	Mean Diff (95% CI)	t-stats (df)	p-value
Gender				1.23 (-1.12, 3.58)	1.07 (34)	0.294*
	Male	6	14.00 (1.67)			
	Female	30	12.77 (2.71)			
Race					*NR	*NR
	Malay	36	*NR			
Kulliyyah					4.23 (4, 35) [c]	**0.008****
	Kulliyyah of Nursing	25	12.88 (2.40)			
	Kulliyyah of Allied Health Sciences	2	14.00 (2.83)			
	Kulliyyah of Dentistry	2	7.50 (0.71)			
	Kulliyyah of Medicine	6	14.83 (0.98)			
	Kulliyyah of Sciences	1	13.00 (-)			
Year					2.42 (3, 35) [b]	0.084**
	Year 1	3	9.67 (3.79)			
	Year 2	8	14.13 (2.64)			
	Year 3	3	13.00 (2.65)			
	Year 4	22	13.00 (2.18)			
Residency Area					1.42 (2, 35) [b]	0.255**
	Urban	8	11.50 (3.34)			
	Mahallah Khalid Al-Walid	5	14.20 (1.79)			
	Mahallah Ummu Khaltum	19	13.11 (2.31)			
	Mahallah Fatimah Az-Zahra	4	13.75 (2.63)			
Marital Status					*NR	*NR
	Single	36	*NR			
Family History				0.03 (*NR)	*NR	*NR
	Yes	1	13.00 (-)			
	No	35	12.97 (2.63)			
Experience				-0.39 (-2.17, 1.39)	-0.45 (34)	0.659
	Yes	18	12.78 (2.46)			
	No	18	13.17 (2.77)			

Note: Significant level set p-value <0.05, with 95% confident interval (CI); NR: not relevant

*: Independent T-Test; **: One-Way ANOVA

[b]: f-stats; [c]: Post Hoc test was unavailable due to at least one of the groups has fewer than two cases

Table 5: Association between sociodemographic factors and knowledge towards sign and symptoms of breast cancer among undergraduates in IIUM (n=36)

Characteristic	Variables	n	Mean (SD)	Mean Diff (95% CI)	t-stats (df)	p-value
Gender				-1.67	-1.32	0.243*
	Male	6	8.83 (3.06)	(-4.87, 1.54)	(5.29)	
	Female	30	10.50 (1.17)			
Race					*NR	*NR
	Malay	36	*NR			
Kulliyyah					6.28 (4, 35) [c]	**<0.001****
	Kulliyyah of Nursing	25	10.16 (1.52)			
	Kulliyyah of Allied Health Sciences	2	11.00 (0.00)			
	Kulliyyah of Dentistry	2	11.00 (0.00)			
	Kulliyyah of Medicine	6	11.00 (0.00)			
	Kulliyyah of Sciences	1	4.00 (-)			
Year					3.14 (3, 35) [b]	0.361**
	Year 1	3	11.00 (0.00)			
	Year 2	8	10.88 (0.35)			
	Year 3	3	10.67 (0.58)			
	Year 4	22	9.82 (1.69)			
Residency Area					0.28 (2, 35) [b]	0.839**
	Urban	8	10.00 (2.45)			
	Mahallah Khalid Al-Walid	5	9.80 (2.17)			
	Mahallah Ummu Khaltum	19	10.32 (1.42)			
	Mahallah Fatimah Az-Zahra	4	10.75 (0.50)			
Marital Status					*NR	*NR
	Single	36	*NR			
Family History				0.80	*NR	*NR
	Yes	1	11.00 (-)	(*NR)		
	No	35	10.20 (1.71)			
Experience				0.11	0.19	0.847*
	Yes	18	10.28 (1.45)	(-1.05, 1.27)	(34)	
	No	18	10.17 (1.95)			

Note: Significant level set p-value <0.05, with 95% confident interval (CI); NR: not relevant

*: Independent T-Test; **: One-Way ANOVA

[b]: f-stats; [c]: Post Hoc test was unavailable due to at least one of the groups has fewer than two cases

Awareness and Practice of Breast Self-Examination
Awareness of breast cancer and BSE among students is moderate, as evidenced by the mean awareness score. Despite this, the practice of BSE remains low, with only 27.8% of students able to perform BSE correctly. This discrepancy between awareness and practice is concerning and reflects findings by Akhtari-Zavare et al. (2016) and Siti Noorkhairina et al. (2020), who reported similar trends in awareness and practice among health students and the general population in Malaysia.

Gender and Area of Residence
The study found that gender and area of residence significantly influence awareness and practice of BSE ($p<0.001$). Female students, who predominantly reside in Mahallah Ummu Kalthum, exhibit higher awareness levels compared to their male counterparts, yet both genders demonstrate low practice levels. This is consistent with studies by Akhtari-Zavare et al. (2016), which suggest that targeted interventions should consider these demographic factors to improve overall engagement in BSE practices.

Technological Integration in Awareness Programs
The results indicate that traditional methods of breast cancer education might not be sufficient to instill lasting behavioral changes in BSE practices. Integrating technology into awareness programs, such as mobile apps, online tutorials, and virtual workshops, could provide interactive and engaging platforms for students to learn and practice BSE. Previous studies have shown that technology-enhanced learning tools can significantly improve health education outcomes (Massat et al., 2016; Htay et al., 2021).

Limitations and Recommendations:

The study's limitations include its small sample size and single-institution scope, which may restrict the generalizability of the findings. Future research should include larger, more diverse populations across multiple universities to validate these results. Additionally, implementing and evaluating the impact of innovative technological tools in breast cancer awareness programs could offer valuable insights into enhancing KAP among university students.

Conclusion:

This study underscores the moderate levels of knowledge, attitude, and practice regarding breast cancer and BSE among IIUM Kuantan undergraduates, even after an awareness intervention. Addressing these gaps through the integration of advanced technologies in awareness programs could lead to better outcomes in breast cancer education and early detection practices.

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Mammographic Breast Density and Its Associated Findings Among IIUM Kuantan Staff

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Abstract:

Introduction: Mammographic breast density is a strong risk factor for breast cancer. In this study, we investigate the distribution of mammographic density in female staff members from the International Islamic University Malaysia (IIUM) in Kuantan. We also explore the associations between mammographic density and various factors, including age, parity, body mass index (BMI), breastfeeding history, and the usage of hormonal replacement therapy. **Methodology:** A cross-sectional study was conducted, involving 54 female staff volunteers from IIUM Kuantan. All participants underwent digital mammography screening, and their mammographic density was evaluated using the Breast Imaging Reporting and Data System (BI-RADS) classification, which categorizes breast density composition from A to D, from being entirely fatty to extremely dense. The demographic and other relevant data were collected through structured questionnaires and reviewing of medical records. Logistic regression was performed to assess the association between mammographic density and the selected factors. **Result & Discussion:** Most breast density fell into category B (51.9%) and category C (48.1%), with no participants falling under category A or D. Further analysis revealed no statistically significant association between mammographic density with age, parity, BMI, breastfeeding history, or usage of hormonal replacement therapy. **Conclusion:** The relatively even distribution between the mammographic density of B and C categories suggests a balanced representation of breast parenchymal patterns in this population. Although the lack of statistical significance is likely due to the small sample cohort, factors such as age, BMI and breast-feeding history showed weak association with breast density. These findings contribute to the existing knowledge on breast health and may aid in the future development of tailored screening and prevention strategies.

Keywords: breast density, digital mammography, BI-RADS

Introduction:

Mammography is a recommended screening method for early detection of breast cancer. The prognosis improves with earlier diagnosis stages (Sant et al., 2003, Mahmud & Aljunid, 2018) . Mammography also helps to identify high risk women by determining mammographic breast density. Women who have densities of over 75% of their breasts have a four to six times higher risk of developing breast cancer than women of the same age who do not have any densities (Heng et al., 2004). This study describes the prevalence of mammographic breast density according to the BI-RADS among female IIUM staff and determines an association between breast density with age, parity, breastfeeding, BMI and usage of hormonal replacement therapy.

Materials and Methods:

This is a cross-sectional study involving female IIUM Kuantan staff who underwent mammography examination at the Department of Radiology, SASMEC @ IIUM between 1st January 2022 to 31st December 2022. The ethical approval was obtained from the Kulliyyah of Medicine Research Committee (KRC), International Islamic University Malaysia (IIUM), and IIUM Research Ethics Committee (IREC). The recruitment of the participants was done in collaboration with the Department of Family Medicine colleagues who studies about "Breast Awareness and Mammography Uptake Among SASMEC and IIUM Kuantan Staff". The staff who took part in their questionnaires and were keen for mammogram examination were directed to us via a shared database. Participants were then contacted by the co-investigator through phone calls or WhatsApp application. A suitable appointment date and time were given for the mammogram study. Subsequently, all mammograms performed were traced from the Radiology Information System (RIS). A total of 54 mammogram examinations that fulfilled the criteria were retrieved and selected into the study. Exclusion criteria are those who were already diagnosed with breast cancer and currently on mammogram follow-up and those who had previous local surgical procedures which affect the breast parenchyma pattern. Digital mammography examinations were performed using *Siemens Mammomat Inspiration*. Two-view images were acquired in cranial-caudal and medial-lateral oblique. Images were then transferred from the workstation into the Digital Imaging and Communication in Medicine (DICOM) format. Data were also acquired from the radiology information system (RIS) mammography form in addition with the pre-designed self-administrative questionnaire containing family history and personal details including the age, height, weight, parity, breastfeeding and hormonal replacement therapy (HRT) usage. The sociodemographic details and corresponding mammogram findings were assessed and tabulated. Data collection was performed by a single person. Images from the picture archiving communication system (PACS) were assessed and data from the RIS and questionnaire were charted into a Microsoft Excel worksheet for data collection. These data were then transferred from Microsoft Excel to a Statistical Package for the Social Sciences (SPSS) version 26.0; SPSS by IBM in New York for analysis.

The mammographic breast density composition was assessed according to the ACR BI-RADS classification i.e., A: almost entirely fatty, B: scattered areas of fibroglandular density, C: heterogeneously dense, and D: extremely dense. BI-RADS C and D are considered as dense breasts with higher risk of breast cancer. The rest of the findings and associated features were interpreted and final BI-RADS assessment categories were recorded. BI-RADS Category 1 indicates normal mammogram, Category 2 indicates findings that are typically benign and not suspicious for malignancy, Category 3 shows a probably benign lesion that needs short follow-up and Category 4 and 5 are those with suspicious abnormality. The sociodemographic data including the age, weight, height, number of children, family history of breast cancer, breastfeeding history and history of hormone replacement usage of the staff were also recorded. Body mass index (BMI) variable was calculated using the weight and height variables. Descriptive analysis was done to assess the prevalence of breast density according to BI-RADS classification. Multiple logistic regression was used to analyse the association of breast density with age, parity, breastfeeding, BMI, and the usage of hormonal replacement therapy.

Results:

A total of 54 patients participated in the study. The sociodemographic characteristics are presented in the table below (Table 1). The average age of the participants was 46.56 years, with a standard deviation of 5.19. In terms of family history of breast cancer, 77.8% (n=42) reported no family history, while 22.2% (n=12) had a positive family history. Regarding the number of parities, 31.5% (n=17) are nulliparous. Breastfeeding history showed that majority 51.9%

(n=28) did not breastfeed. The participants had an average BMI of 27.0, with a standard deviation of 4.79. In terms of hormonal replacement therapy or birth control pill usage, mostly 55.6% (n=30) reported never using them.

Table 1: Sociodemographic distribution

Sociodemographic		**N**	**Percentage (%)**
Family History of Breast Cancer	No	42	77.8
	Yes	12	22.2
Number of Parity	0	17	31.5
	1	3	5.6
	2	10	18.5
	3	9	16.7
	More than 4	15	27.8
Breastfeeding History	None	28	51.9
	Less than 12 Months	13	24.1
	12 – 24 Months	8	14.8
	24 – 36 Months	5	9.3

The prevalence of breast density according to the BI-RADS classification shows 51.9% (n=28) were classified under Category B, while 48.1% (n=26) fell into Category C. None of the participant has breast density of category A and D. Regarding the final assessment categories according to BI-RADS score (Table 2), majority of patients, 64.8% (n=35), were classified under BI-RADS 2. Additionally, 13.0% (n=7) were classified under BI-RADS 1, while 22.2% (n=12) fell into BI-RADS 3; while no participants were classified under BI-RADS 4 or 5. Table 3 shows a summary of the distribution of BI-RADS classifications within different Breast Density categories. There is no statistically significant association between Breast Density and BI-RADS classifications (p-value = 0.952). This suggests that the distribution of BI-RADS classifications is similar across different Breast Density categories (B and C).

Table 2: Distribution of BI-RADS Category Among Staff Who Underwent Mammography

BI-RADS Category	**N**	**Percentage (%)**
1- Normal	7	13.0
2 - Benign	35	64.8
3- Probably benign	12	22.2
4,5-Suspicious and Malignant	0	0
Total	54	100

Table 3: Breast Density and BI-RADS categories classification

Breast Density	BI-RADS			Total	p-value
	1	2	3		
B	4 (7.4%)	18 (33.3%)	6 (11.1%)	28 (51.9%)	0.952
C	3 (5.6%)	17 (31.5%)	6 (11.1%)	26 (48.1%)	
Total	7 (13%)	35 (64.8%)	12 (22.2%)	54 (100%)	

Descriptive statistics and multiple logistics regression were used to determine the association of breast density with age, parity, breastfeeding, BMI and usage of hormonal replacement therapy. These are shown in Table 4. It revealed that the mean age of the participants in Breast Density Category B was 47.36 years (SD = 5.97), while in Breast Density Category C, it was slightly lower at 45.69 years (SD = 4.15). There is no difference in the distribution of breastfeeding history and parity among participants across different Breast Density categories. A slightly more women with higher mean BMI had denser breast in Category B. A slightly higher number of women with denser breasts were also noted to use of HRT.

Table 4: Association between breast density with demographic data

Demographic		Breast Density, (Mean (SD) / N (%))			
		A	B	C	D
Age		0 (0)	47.36 (5.97)	45.69 (4.15)	0 (0)
Parity	0	0 (0)	9 (16.7)	8 (14.8)	0 (0)
	1	0 (0)	2 (3.7)	1 (1.9)	0 (0)
	2	0 (0)	5 (9.3)	5 (9.3)	0 (0)
	3	0 (0)	6 (11.1)	3(5.6)	0 (0)
	More than 4	0 (0)	6 (11.1)	9 (16.7)	0 (0)
Breastfeeding History	None	0 (0)	17 (31.5)	11 (20.4)	0 (0)
	Less than 12 Months	0 (0)	5 (9.3)	8 (14.8)	0 (0)
	12 – 24 Months	0 (0)	4 (7.4)	4 (7.4)	0 (0)
	24 – 36 Months	0 (0)	2 (3.7)	3 (5.6)	0 (0)
BMI		0 (0)	27.68 (4.54)	26.27 (5.03)	0 (0)
Usage of Hormonal Replacement Therapy / Birth Control Pills	Never	0 (0)	14 (25.9)	16 (29.6)	0 (0)
	Current Use	0 (0)	2 (3.7)	5 (9.3)	0 (0)
	Former Use	0 (0)	12 (22.2)	5 (9.3)	0 (0)

Table 5: Correlation between breast density with demographic data

	B	S.E.	Significant	Exp(B)	95% C.I. for EXP(B)	
					Lower	Upper
Age	-0.077	0.063	0.223	0.926	0.817	1.048
Number of Parity	-0.057	0.223	0.798	0.945	0.610	1.463
Breastfeeding History	0.417	0.363	0.251	1.518	0.745	3.093
BMI	-0.088	0.067	0.193	0.916	0.803	1.045
Usage of Hormonal Replacement Therapy / Birth Control Pills	-0.625	0.351	0.075	0.535	0.269	1.065
Constant	6.123	3.766	0.104	456.231		

Table 5 shows for each one-unit increase in age, the odds of having lower breast density increase by a factor of 0.926 (or 7.4% decrease). However, this effect is not statistically significant. There is no clear evidence of a relationship between the number of children a woman has given birth to and her breast density. The odds of having higher breast density for women with a history of breastfeeding are 1.518 times higher than for women without a breastfeeding history. However, this effect is also not statistically significant. With every one-unit increase in the BMI, the odds of having higher breast density decrease by a factor of 0.916 (or 8.4% decrease). However, this effect is not statistically significant. There is weak evidence (p = 0.075) suggesting a possible association between the Usage of Hormonal Replacement Therapy / Birth Control Pills and breast density. Women who use hormonal replacement therapy or birth control pills have 0.535 times lower odds of having higher breast density compared to those who do not use them. However, this effect is also not statistically significant. Overall, based on the provided results, none of the variables show a significant association with breast density.

Discussion:

Mammographic density has been reported as one of the strongest risk factors for breast carcinoma (McCormack & Dos Santos Silva, 2006; Olsen et al., 2009). Our study showed that the distribution of breast density was relatively evenly split between breast density category B and C, 51.9% (n=28) versus 48.1% (n=26) respectively. This is relatively similar with a local study conducted by Hanis et al. (2022) who found 54.3 % of their cohort fell into non-dense categories (A &B) and 37% fell into dense categories (C & D). A comparison with the study conducted in the United States (Checka et al., 2012) showed that breast density category C was most frequently recorded (46%), followed by category B (37%), category D (9%), and category A (8%). It can also be observed that most of the subjects who fell into category A and D were older than 60 years old and younger than 40 years old respectively. In our study, due to the small cohort there was no subject in category A & D density. This is because our study was only conducted among working personnel of a relatively new medical centre and university in which the age range of our subjects was small ranging only from 40 to 66 years old.

Our study revealed that for each one-unit increase in age, the odds of having higher breast density is also decreased, however it is statistically not significant (p = 0.223). This is in contrast with multiple previous studies which have found a statistically significant trend of inverse relationship between age and mammographic density (Azam et al., 2019; Duffy et al., 2018; Hanis et al., 2022; Shang et al., 2021; Zulfiqar et al., 2011). Mammographic density decreased as the women aged, particularly around the menopausal age (Vourtsis & Berg, 2019). Again, this result may be likely due to small study cohort.

Regarding the number of parities, majority of the subjects in our study were parous (68.5%), similar to

previous study conducted by Heng et al. (2004) where 78% of the subjects were parous with the average number of deliveries was 2.9. However, our study showed no clear evidence of a relationship between the parity and breast density. This contradicts with several previous studies which have actually proved inverse association between parity and breast density (Hanis et al., 2022; Heng et al., 2004; Sung et al., 2018; Yaghjyan et al., 2012).

In our study, the odds of having higher breast density for women with a history of breastfeeding are 1.518 times higher than for women without a breastfeeding history. However, this effect is also not statistically significant. Several studies found a similar finding whereby there is no association between breastfeeding duration and breast density (McCormack et al., 2008; Tseng et al., 2007). Other authors, however, report detecting positive association between duration of lactation and breast density (Azam et al., 2019; Santamarin et al., 2012).

The mean BMI of our study cohort is 27.0, with a standard deviation of 4.79 which is considered overweight according to the World Health Organization (WHO) BMI reference. Similarly, the mean BMI of previous studies conducted by Yaghjyan et al. (2012) and Hanis et al. (2022) were also fall into overweight range. Past studies have consistently shown that BMI is inversely associated with breast density (Azam et al., 2019; El-Bastawissi et al., 2000; Hanis et al., 2022; Shang et al., 2021; Shamsi et a., 2021; Yaghjyan et al., 2012). In our study, we found that for every one-unit increase in BMI, the odds of having higher breast density decrease by a factor of 0.916 (or 8.4% decrease). However, this effect is not statistically significant.

Previous studies have shown a positive association between hormonal replacement therapy / birth control pills usage and breast density (Azam et al., 2019; Greendale et al., 2003; Rutter et al., 2001). HRT users were more likely to maintain or have increase breast density (Rutter et al., 2001). Unlike these investigations, we did not observe an association of hormonal replacement therapy/ birth control pills usage with breast density. However, the prevalence of HRT/ birth control pills in our study was low, reducing our power to detect an association.

Conclusion:

Our study showed that the distribution of breast density was relatively evenly split between dense and non-dense breasts. Even though the not statistically significant result is likely due to small sample cohort, some factors such as age, BMI and breast-feeding history have shown some association with breast density as reported in other series. These findings can contribute to existing knowledge on breast related diseases and may aid in the development of tailored screening and prevention strategies. Further research with larger sample sizes and more diverse populations is warranted to validate the results and explore additional factors such as menopausal status, physical activity and dietary lifestyle which may influence mammographic density.

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Nutritional Status and Prevalence of Hypertension among Teachers in Yewa North Local Government, Ogun State, Nigeria

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Abstract:

Introduction: The global incidence of hypertension has been steadily increasing, raising significant public health concerns. Various factors, including inadequate nutrition, have been linked to the development of hypertension. **Objective:** The purpose of the study was to evaluate the prevalence of hypertension and the nutritional status of teachers in Yewa North Local Government, Ogun State, Nigeria. Materials and Methods: A sample size of 390 participants, aged 18 to 59, who lived in the Yewa North Local Government Area were chosen using a cross-sectional and descriptive methodology. A systematic questionnaire, anthropometric measures, and blood pressure readings were used to gather data. **Results:** With 42.8% of the teachers being classed as overweight and 24.4% as obese, the results demonstrated a high prevalence of overweight and obesity among the teachers. Compared to female teachers, overweight was more common among male teachers. Less than half of the participantshad normal systolic blood pressure, indicating a high prevalence of abnormal blood pressure. Significant percentages of the subjects had elevated (pre-hypertension), stage I, and stage II hypertension. Compared to female teachers, male teachers were more likely to have stage I hypertension. **Conclusion and Implication:** These results imply that the anomalous nutritional condition of a considerable proportion of teachers in Yewa North Local Government may put them at risk of hypertension.

Keywords: High blood pressure, Hypertension, Nutritional status, Teachers, Anthropometric

Introduction:

Globally, the incidence of hypertension has been rising leading toserious concerns for public health (Ayogu et al., 2021). The development of hypertension has been linked to a number of factors, including inadequate nutritional status (Carey et al., 2018). Hypertension or high blood pressure which is a global health concern is defined by abnormally high blood pressure in the arteries. It poses a significant risk for cardiovascular illnesses as well as other grave health issues (Singh et al., 2017). The World Health Organization (WHO) estimates that one billion people globally suffer from hypertension, which significantly causes morbidity and death (WHO, 2023). In order to improve health outcomes and to put into practice effective preventative strategies, it is imperative to comprehend the factors that contribute to the development of hypertension. An estimated one in three people in Nigeria suffer from hypertension, making it a prevalent condition in the country (Davies et al., 2022; Augustine et al., 2020). Genetic predisposition, sedentary lifestyle, obesity, and poor food choices are among of the variables that lead to the development of hypertension (Ayogu et al., 2021).

One of the important factors in the emergence and treatment of chronic illnesses, such as hypertension, is nutritional status. A higher risk of hypertension has been associated with poor dietary practices, such as consuming excessive amounts of saturated fats, less fruits and vegetables, and high sodium intake (Mills et al., 2020). The impact of a healthy diet on one's overall health and wellbeing cannot be overstated. Given its significant influence on immune function, illness susceptibility, physical and mental development, and immunity, nutritional status has been extensively researched as a crucial predictor of health in a variety of demographic groups (Khan et al., 2023). The nutritional status of Nigerian adults has become increasingly challenging in recent years due to rapid urbanization, changing eating habits, and altered lifestyles. These developments call for a better understanding of the nutritional status of many demographic groups, including teachers, as they are frequently accompanied by an increase in non-communicable diseases such obesity, high blood pressure, diabetes, and cardiovascular diseases (Zhang et al., 2023). Teachers are among the many professional groups that have an impact on how society develops, and they play a critical role in molding the next generation. Teachers are the foundation of educational systems, shaping children's minds and making a major contribution to the advancement of society (Uchechi et al., 2021). Nevertheless, their hard job frequently entails lengthy workdays, high stress levels, and little time for self-care, which may have an effect on their personal diet and health decisions (Agyapong et al., 2022). Teachers may be particularly vulnerable to poor nutrition and unhealthy eating habits because of their hectic schedules and frequently restricted access to wholesome meal options. Teachers may also have sedentary lifestyles and frequently deal with high amounts of stress, which increases their risk of hypertension. Blood pressure has been demonstrated to be physiologically affected by stress, and inactivity is linked to a number of health hazards, including hypertension (Tsubono et al., 2023).

Despite the potential risks, little is known about the prevalence of hypertension and the nutritional status of teachers. This study aims to fill this research gap by conducting a comprehensive investigation into the nutritional status and prevalence of hypertension among the teachers.

Materials and Methods:

In Yewa North Local Government, Ogun State, Nigeria, a cross-sectional and descriptive study was conducted to evaluate the nutritional status and prevalence of hypertension among teachers. A total of 422 individuals, aged 18 to 59, residing in the Yewa North Local Government Area were selected for the study. The sample size was determined using an appropriate formula for cross-sectional studies, considering a 5% margin of error and a 95% confidence level, based on the estimated population of teachers in the area.

Sample Size Determination

The minimum sample size was calculated using the statistical formula:

$$n = \frac{Z^2 (p) (q)}{d^2}$$

Where Z is the Z score value at 95% confidence interval (CI) = 1.96
n = Minimum sample size
Z = 1.96
d = (0.05)
p = 50%
q = 1-p (=0.5)

$$n = \frac{1.96^2 (0.5) (0.5)}{(0.05)^2}$$

n = 384.24

Ten percent (10.0 %) of the minimum sample size calculated using the above formula was introduced

to compensate for non-response.
Thus, 10.0% of 382.24 = 38.2
384.24+38.2 = 422 Approximately

Data collection

A structured questionnaire was administered to collect relevant demographic and socioeconomic data, including age, sex, marital status, educational level, household income, and number of dependents. Anthropometric measurements, including weight, height, visceral fat, were collected following standardized procedures. The Body Mass Index (BMI) was calculated as weight (kg) divided by height (m^2) and categorized as underweight, normal weight, overweight, and obese, using established cutoff values. The blood pressure was measured using an automated sphygmomanometer. Three consecutive blood pressure measurements were taken after participants have been seated and rested for at least 5 minutes. The average of the three measurements was recorded as the participant's blood pressure.

Ethical Considerations

Prior to starting data collection, ethical approval was obtained from the Ogun State Hospital, Ijaye Abeokuta Research Ethics Committee (Ref. no: SHA/RES/VOL/XII/162). Informed consent was acquired from all participants, and the study always ensured the privacy of their personal data.

Data Analysis

Descriptive statistics, such as the means, standard deviations, frequencies, and percentages was used to summarize the data collected, including anthropometric measurements and demographic variables. The prevalence of undernutrition and overweight/obesity among teachers was determined based on the BMI cutoff values. The Fisher exact test was used to assess the association between nutritional status and demographic variables.

Results:

Table 1 provides information on the socio-economic and demographic characteristics of the participants. It can be observed that most of the participants had secondary (14.4%) or tertiary (85.6%) education. In terms of monthly income, the highest percentage (39.7%) fell in the range of 61,000-90,999, followed by 31,000-60,999 (24.9%). Most of the participants had access to electricity (78.7%) for lighting, had brick housing type (62.3%), and used water closet toilets (80.0%). Additionally, most participants used borehole water as their source of drinking water at home (61.5%). The primary source of cooking fuel for most participants was gas (77.9%).

Table 1: Socio-economic and Demographic Characteristics of the participants

Variable	Frequency	Percentage
Age (years) Mean= 40.6±9.4 years		
<29	65	16.7
30-39	102	26.2
40-49	154	39.5
50 and above	69	17.7
Ethnicity		
Hausa	23	5.9
Yoruba	316	81.0
Ibo	42	10.8
Others (Urhobo, Esan, Ijaw)	9	2.3
State of Origin		
Ekiti	5	1.3
Lagos	5	1.3
Ondo	27	6.9
Ogun	230	59.0
Osun	32	8.2
Oyo	33	8.5
Others (Anambra, Benue, etc.)	58	14.9
Religion		
Christianity	276	70.8
Islam	103	26.4

Traditional	5	1.3
Others	6	1.5
Family type		
Monogamous	290	74.4
Polygamous	100	25.6
Family size		
≤3	41	10.5
4-5	228	58.5
6-7	101	25.9
Others (>7)	20	5.1
Education		
Informal	0	0.0
Primary	0	0.0
Secondary	56	14.4
Tertiary	334	85.6
Estimated Monthly Income		
≤30,000	58	14.9
31,000-60,999	97	24.9
61,000-90,999	155	39.7
91,000-120,999	55	14.1
≥121,000	25	6.4
Energy for lightning?		
Electricity	307	78.7
Generator	53	13.6
Solar	15	3.8
Lantern/candle/wick	8	2.1
Others	7	1.8
Housing Type		
Mud	7	1.8
Brick	243	62.3
Concrete	138	35.4
Others	2	0.5
Toilet Type		
Latrine	71	18.2
Water Closet	312	80.0
Bush	4	1.0
Others	3	0.8
Source of drinking water at home		
Well	33	8.5
Stream	11	2.8
Tap	94	24.1
Borehole	240	61.5
Sachet	12	3.1
Total	390	100.0

The nutritional status expressed as Body Mass Index (BMI) is presented in Table 2. It was noted that 30.5% of the participants had a normal BMI, 24.4% were obese while the majority of them were overweight (42.8%). Gender differences were also observed in the study in which most males (51.6%) were overweight compared to females (36.8%). On the other hand, more females (32%) were found to be obese compared to males (13.1%). Overall, the majority of the participants (69.5%) had abnormal nutritional status, including underweight, overweight, and obesity. The association between the nutritional status (BMI) of the male and female participants was found to be statistically significant ($p<0.05$). Furthermore, the study examined visceral fat among the participants and found that the majority (60.5%) had normal visceral fat, while 36.9% had high visceral fat and 2.6%

ad very high visceral fat. More females (65.4%) than males (53.5%) had normal visceral fat, while more males (44.0%) than females (32.0%) had high visceral fat.

Table 2: Association between Body Mass Index and Gender of the participants

Body Mass Index	Male N (%)	Female N (%)	Total	X^2	p-Value
Underweight (<18.5)	6 (3.8)	3 (1.3)	9 (2.3)	24.165[a]	0.000
Normal weight (18.5-24.9)	50 (31.4)	69 (29.9)	119 (30.5)		
Overweight (25.0-29.9)	82 (51.6)	85 (36.8)	167 (42.8)		
Obesity Class I (30.0-34.9)	19 (11.9)	50 (21.6)	69 (17.7)		
Obesity Class II (35.0-39.9)	1 (0.6)	11 (4.8)	12 (3.1)		
Obesity Class III (≥40.0)	1 (0.6)	13 (5.6)	14 (3.6)		
Total	159 (100.0)	231 (100.0)	390 (100.0)		

Table 3: Systolic Blood of the participants

Systolic Blood Pressure	Male N (%)	Female N (%)	Total (N%)	Exact	p-Value
Normal (<120.00)	53 (33.3)	97 (42.0)	150 (38.5)	9.748[a]	0.054
Elevated (120.00-129.99)	30 (18.9)	40 (17.3)	70 (17.9)		
Stage I (130.00-139.99)	35 (22.0)	31 (13.4)	66 (16.9)		
Stage II (≥140.00)	41 (25.8)	63 (27.3)	104 (26.7)		
Total	159 (100.0)	231 (100.0)	390 (100.0)		
Diastolic Blood Pressure					
Normal (<80.00)	65 (40.9)	119 (51.5)	184 (47.2)	4.868[a]	0.181
Stage I (80.00-89.99)	55 (34.6)	72 (31.2)	127 (32.6)		
Stage II (≥90.00)	39 (24.5)	40 (17.3)	79 (20.3)		
Total	159 (100.0)	231 (100.0)	390 (100.0)		

The blood pressure of the participants is presented in Table 3. Less than half (38.5%) of the participants had normal systolic blood pressure while 17.9%, 16.9% and 26.7% had elevated (pre-hypertension), stage I and II hypertension respectively. A higher percentage of females (42.0%) compared to males (33.3%) had normal systolic blood pressure. Conversely, more males had elevated (18.9%) and stage I hypertension (22.0%) compared to females (17.3% and 13.4 %, respectively). Additionally, a slightly higher percentage of females (27.3%) than males (25.8%) participants had stage II hypertension.

Less than half (47.2%) of the participants had normal diastolic blood pressure while 32.6% and 20.3% had stage I and II hypertension respectively. It was noted that more females (51.5%) than males (40.9%) participants had normal diastolic blood pressure. On the contrary, more males (34.6%, 24.5%) than females (31.2%, 17.3%) participants had stage I and II hypertension respectively. Based on Table 4, the study revealed a statistically significant relationship between nutritional status and blood pressure.

Table 4: Association between Blood Pressure and Nutritional Status of the participants

	Body Mass Index (Nutritional Status)					X^2	p-Value
	Under-weight N (%)	Normal N (%)	Over-weight N (%)	Obese N (%)	Total (N%)		
Systolic Blood Pressure							
Normal (<120.00)	6 (66.7)	67 (56.3)	50 (29.9)	16 (16.8)	139 (35.6)	47.927[a]	0.000
Pre-hypertension (120.00-139.99)	3 (33.3)	32 (26.9)	72 (43.1)	40 (42.1)	147 (37.7)		

Stage I (140.00-159.99)	0 (0.0)	14 (11.8)	36 (21.6)	31 (32.6)	81 (20.8)		
Stage II (≥160.00)	0 (0.0)	6 (5.0)	9 (5.4)	8 (8.4)	23 (5.9)		
Total	9 (100.0)	119 (100.0)	167 (100.0)	95 (100.0)	390 (100.0)		
Diastolic Blood Pressure							
Normal (<80.00)	6 (66.7)	66 (55.5)	81 (48.5)	29 (30.5)	182 (46.7)	18.089[a]	0.034
Pre-hypertension (80.00-89.99)	3 (33.3)	30 (25.2)	52 (31.1)	44 (46.3)	129 (33.1)		
Stage I (90.00-99.99)	0 (0.0)	13 (10.9)	18 (10.8)	11 (11.6)	42 (10.8)		
Stage II (≥100.00)	0 (0.0)	10 (8.4)	16 (9.6)	11 (11.6)	37 (9.5)		
Total	9 (100.0)	119 (100.0)	167 (100.0)	95 (100.0)	390 (100.0)		

Discussion:

In Yewa North Local Government, Ogun State, Nigeria, teachers' nutritional status and the prevalence of hypertension were evaluated in this cross-sectional and descriptive study. In a research paper titled "Overweight/obesity in teachers: prevalence and associated factors," Rochas et al. (2015) discovered that teachers had a higher prevalence of overweight and obesity compared to the national average for individuals in the same age range. This is in line with the results of our study, which showed that 24.4% of participants were obese and 42.8% of participants were overweight. Similar findings were observed in three other studies (Saulo et al., 2015; Pizadeh et al., 2023; Monteiro et al., 2003), all indicating significant rates of overweight and obesity among teachers. Additionally, our study found a noteworthy gender disparity, with a higher percentage of overweight male teachers compared to female teachers. This is consistent with our data, which showed that 36.8% of females and 51.6% of males were overweight. However, other studies (Fadupin et al., 2014; Ckukwuonye et al.,2022; Emmanuel et al., 2020) reported lower prevalence rates of overweight and obesity among teachers compared to our study. . The authors attributed this discrepancy to factors such as the teachers' socioeconomic background, years of teaching experience, and educational attainment. There are many potential explanations for the discrepancies in results between our study and previous studies, including the socioeconomic and demographic makeup of the study group, cultural influences on eating customs, and accessibility to medical facilities. Overall, our study findings indicate that a substantial proportion of teachers are overweight or obese, and that inadequate nutritional status is highly prevalent. Given the teachers' critical role in shaping students' education and future, it is essential to prioritize their health and well-being. Teachers should be encouraged to adopt healthy lifestyle practices, such as eating nutritious meals and engaging in regular exercise.

To enhance the overall well-being of teachers in Yewa North Local Government, Ogun State, Nigeria, interventions aimed at improving the socioeconomic and environmental aspects, such as access to healthy food and healthcare facilities, should be given top priority. The sedentary nature of teaching may contribute to the high rates of overweight and obesity among educators as they often have limited opportunities for physical activity and spend long hours seated. Furthermore, teaching is a profession that frequently experiences stress and heavy workload, both of which can lead to poor eating habits and weight gain (Schultz, 2020; Delfino et al., 2020). Previous research has similarly reported the gender disparities observed in our study, with more males being overweight and more females being obese (Alwan, 2010; Pizadeh et al., 2023). These differences may be attributed to variations in hormone levels and body composition between males and females.

This study also evaluated individual blood pressure levels. Less than half of the participants had normal systolic blood pressure. The findings revealed that 17.9%, 16.9%, and 26.7% of the subjects had elevated (pre-hypertensive), stage I, and stage II hypertension, respectively. There was gender-specific variations in the prevalence of hypertension. More women than men had normal systolic blood pressure, while more men than women had elevated and stage I hypertension. These results are consistent with recent research (Davies et al., 2022; Pizadeh et al., 2023) showing a higher prevalence of hypertension in men. The prevalence of stage II hypertension did not differ significantly between males and females.

Overall, our findings highlighted a high percentage of teachers who may be at risk of hypertension due to their inadequate nutritional state. This is consistent

with a study by Ibrahim et al. (2013) which identified BMI as the most significant modifiable risk factor and found that pre-hypertension and hypertension were highly prevalent among teachers in Jeddah. These results are significant because they emphasize the necessity of programmes and interventions aimed at promoting the health and well-being of teachers (Hascher et al., 2021). Hypertension among teacher can be prevented and managed by promoting good lifestyle choices, including nutritional education, and regular physical activity. The underlying causes of the significant frequency of inadequate nutritional status and hypertension among teachers require more investigation. This can help in developing targeted interventions and strategies to improve teachers' overall health and well-being. It is important to note that limitations might have affected the generalizability of the study's conclusions. The samples consisted of teachers from a specific area or school system, which may not accurately represent all teachers in the country.

Conclusion:

This study provides important new insights into the prevalence of hypertension and the nutritional health of teachers. The results emphasize the need for programmes and interventions aimed at promoting the health and wellness of teachers, particularly in terms of blood pressure management and nutritional status.

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Development & Evaluation of an Animated Video on Healthy Weight Gain and Energy Intake During Pregnancy for Stunting Prevention

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Abstract:

Introduction: Maternal nutrition during pregnancy is crucial for foetal growth, infant health, and survival. Undernutrition in expectant mothers can cause foetal intrauterine growth retardation, low birth weight, and child stunting. As such, effective communication of nutritional information is essential for promoting healthy behaviours among pregnant women. However, despite the worrying prevalence of stunting in Malaysia and the important role of maternal nutrition during the first thousand days of life, there are limited education tools available regarding the recommended maternal nutrition for stunting prevention. Therefore, this study aimed to develop and evaluate an animated video on healthy weight gain and the recommended total calorie intake during pregnancy to prevent stunting. **Methodology:** A design-and-development research method was employed to create the video, incorporating expert reviews and systematic evaluation processes. The video content was derived from established guidelines and refined through expert workshops. The Suitability Assessment of Materials (SAM) tool and the Patient Education Materials Assessment Tool for Audiovisual Materials (PEMAT-A/V) were used to evaluate the video's suitability, understandability, and actionability. This was conducted among a panel of six experts and a subsample of target viewers, comprising 30 women who were pregnant or had been pregnant within the previous 12 months. **Results:** The video received a 72%

suitability score, categorising it as superior material. Experts rated the video's understandability at 80% and actionability at 92%, while the target viewers rated understandability at 92% and actionability at 93%. The video effectively communicated the importance of healthy weight gain during pregnancy and adequate energy intake, providing actionable steps for women to follow. **Conclusion:** The newly developed animated video was demonstrated to have desirable levels of suitability, understandability, and actionability. This indicates the animated video's potential as a nutrition education tool to deliver nutritional knowledge to pregnant mothers and prevent stunting prevalence in their children.

Keywords: Child stunting, Education tools, Exclusive breastfeeding, Maternal nutrition, Pregnancy, Videos

Introduction:

Maternal undernutrition during pregnancy has been identified as a major determinant of foetal intrauterine growth retardation, infant low birth weight, and child stunting during growing up (Black et al., 2013). This includes an unhealthy diet by the mother before, during, and after pregnancy, which could hinder the early growth of the child starting from conception (Wong, 2019). Stunting, or short-for-age, is due to inadequate nutrient intake and absorption compared to needs. According to the World Health Organization (WHO), children are defined as stunted if their height-for-age is more than two standard deviations below the WHO Child Growth Standards median (WHO, 2015). In Malaysia, the National Health and Morbidity Survey 2019 reported that the prevalence of stunted children increased to 21.8 percent compared to 20.7 percent in 2016 (Institute for Public Health, 2020).

Impaired nutritional status of mothers during pregnancy also determines long-term child health and development (Black et al., 2013). The first 1000 days of life span (from conception until a child reaches the age of two) are the most critical. During the first half of this period, the developing child relies on the mother as the sole source of nutrition, both in utero and during the first six months of life, when exclusive breastfeeding is recommended (Mason et al., 2014). Therefore, adequate energy intake and healthy weight gain during pregnancy are essential for optimal foetal development and the prevention of low birth weight and stunting (National Coordinating Committee on Food and Nutrition (NCCFN), 2017).

Patient education is essential for improving patients' health literacy, empowerment, and participation in disease management (WHO, 2006). In line with the WHO's global strategy to improve health for everyone, everywhere, by accelerating the development and adoption of accessible, affordable, and sustainable digital health solutions, the use of information and communications technologies (ICT) is becoming essential to enable more people to enjoy better health and well-being (WHO, 2020). Technology advancement has enabled health professionals to innovate ways of communicating knowledge with the public. In fact, the transition towards digital technologies has been expedited by the COVID-19 pandemic, highlighting the significance of inventive health communication techniques (Doraiswamy et al., 2020).

Effective communication of nutritional information is crucial for promoting healthy behaviours among pregnant women. However, despite the alarming prevalence of stunting in Malaysia and the critical role of maternal nutrition during the first thousand days of life, there are only a limited number of nutrition education tools available here on the recommended maternal nutrition to prevent stunting, particularly in a digital format. Digital platforms have the potential to disseminate health information rapidly to many people and are strongly advocated by the WHO. Animated videos offer a promising solution by providing engaging, accessible, and culturally appropriate educational content. These videos can enhance understanding and retention of information, making them a valuable tool for health education. As such, this study aimed to develop and evaluate an animated video to educate women on the recommended total calorie intake and healthy weight gain during pregnancy to minimise stunting development among their babies.

Materials and Methods:

Study Design

This study utilised the design and development research method to develop and evaluate an animated nutritional education video on healthy total calorie intake and the recommended weight

gain for women during pregnancy. This study design establishes a systematic method for design, development, and evaluation processes to create instructional and non-instructional tools (Richey and Klein, 2007).

Part 1: Development of Video

The contents of the video were determined through a review of available guidelines and deliberated in a series of workshops for a bigger research project, which was attended by experts in nutrition and dietetics at the International Islamic University Malaysia (IIUM). The video's current topic was one of the subtopics for the healthy maternal nutrition during pregnancy module.

A storyboard and script for the video were drafted and evaluated by an expert (research supervisor). Based on this, a video draft was created and underwent evaluation in terms of suitability, understandability, and actionability.

Part 2: Evaluation of Video

Evaluation of Suitability

The evaluation of suitability was originally done to systematically assess the suitability of healthcare materials for patient populations. There are many factors that need to be considered to evaluate the suitability of materials, such as content, literacy demand, graphics, layout, learning stimulation or motivation, and the culture of the intended viewers (Doak et al., 1996). In assessing the suitability of the video, the Suitability Assessment of Materials (SAM) tool (Doak et al., 1996) was used using an online survey. This consists of four areas: i) Content; ii) Literacy Demand; iii) Graphics; and iv) Cultural Appropriateness. There are three categories where each material's numerical score (in percent) may fall: superior, adequate, or not suitable. Two points would be given for the superior rating, one point for adequate rating, and zero points for the not-suitable rating. The scores would be added up to obtain a total score, which would be converted into a percentage. The interpretation of suitability assessment material percentage ratings is: 0-39% (not suitable material), 40-69% (adequate material), and 70-100% (superior material) (Doak et al., 1996).

The suitability assessment was conducted by a panel of six experts in nutrition and dietetics. They were selected based on their academic background and a minimum of five years' working experience. It is recommended that the assessment process involve a minimum of six but not more than ten specialists (Yusoff, 2019).

Evaluation of Understandability and Actionability

The evaluation of understandability and actionability was done to help viewers determine whether they were able to understand and act on the information (Shoemaker et al., 2014). The evaluation consisted of two factors: understandability and actionability. The answers for each question were either "disagree" (awarded zero points) or "agree" (one point). The total points for understandability were summed up, divided by the total possible points, and converted into a percentage. The higher the percentage, the more understandable the material is. The same method was applied for actionability, where the points were summed up, divided by the total possible points, and converted into percentages. In this case, the higher the percentage, the more actionable the material (Shoemaker et al., 2014).

The understandability and actionability of the video were assessed by the six panel of experts (the same individuals who were involved with the evaluation of suitability) using the Patient Education Materials Assessment Tool for Audiovisual Materials (PEMAT-A/V) tool in English (Shoemaker et al., 2014). In addition, the evaluation of the understandability and actionability of the nutrition education video was also conducted among a subpopulation of the intended viewers (N=33) recruited using a convenient sampling method, as the review by subjects drawn from the target population is as important as the experts' (Zamanzadeh et al., 2015). This includes women aged 18 to 45 who were pregnant or were trying to get pregnant. The evaluation was conducted using the PEMAT-A/V tool, which has been translated into Malay (Saddki et al., 2018).

Statistical Analysis

Descriptive statistics were performed with the presentation of continuous data through the mean and standard deviation and categorical data through the absolute number and percentage.

Ethical Approval and Participant Consent

The current study obtained its ethical approval from the International Islamic University Malaysia Research Ethics Committee (Reference No.: IIUM/504/14/11/2/IREC2021-KAHS/DNS). All

the participants provided informed consent prior to their participation in the study. The online questionnaire began with a disclaimer, informing the respondents that their response signifies their voluntary participation in the study.

Results:

Development of video

A nutritional education video draft was produced with a total length of three minutes using the Powtoon® (Powtoon Ltd., London, UK) animation software and edited using an open-source video editing software, Shotcut® (Mellytech, LLC). The video featured animations with a Malay voiceover explanation. It described the importance of sufficient energy intake and maintenance of a healthy weight gain during pregnancy for stunting prevention, as well as the recommended total energy intakes for each pregnancy trimester according to maternal pre-pregnancy BMI categories.

Evaluation of Suitability

Annexure 1 displays the SAM score ratings for the nutritional education video by a panel of six experts. There are four categories that divide the factors: content, literacy demand, graphics, and cultural appropriateness. Most of the experts (66.7%) rated 1 for the 'purpose of the video' factor, which indicates that the purpose of the video was not explicit and was either implied or stated for multiple purposes. All the experts agreed that the essence of the video is the application of knowledge or skills aimed at desirable reader behaviour rather than non-behaviour facts. They also unanimously indicated that the scope of the video is limited to and focused on essential information directly related to the purpose. Experience demonstrates that one can acquire it within the allotted time. Four experts (66.7%) gave a score of 1 for reviewing some key ideas in the video summary.

Only one-third of the respondents rated the vocabulary used as having all three factors: i) the frequent use of common words; ii) the explanation of technical, concept, category, and value judgement (CCVJ) words through examples; and iii) the appropriate use of imagery words in the content. In contrast, all of them agreed that the type of graphics used was simple, adult-appropriate, using line drawings or sketches, and likely to be familiar to the viewers. For relevance of illustrations, two-thirds of the experts rated the video with 2 points because illustrations present key messages visually, so the reader or viewer can grasp the key ideas from the illustrations alone and has no distractions. Regarding the 'lists and tables explained' factor, only two experts (33.3%) agree that step-by-step directions are provided. Two-thirds of the respondents (66.7%) agreed that in the video, there were brief captions used for some illustrations and graphics. Two of them (33.3%) agreed that the central concepts and ideas of the nutritional education video appeared to be culturally similar to the logic, language, and experience (LLE) of the target audience's culture.

The maximum possible score for this evaluation is 96 points (100 percent). The suitability score of the video was 69 points (72%), which is interpreted as superior material for the suitability assessment of material (Doak et al., 1996).

Evaluation of Understandability and Actionability

Regarding understandability, all the experts agreed that the video makes its purpose completely evident, while 83.3% said that the video uses common and everyday language, as shown in Annexure 2. Furthermore, all the experts concurred that the video solely employs medical terms to acquaint the audience with them. When used, medical terms are defined. The six experts also agreed that the video uses active voice. Two-thirds of them said that the video breaks or "chunks" information into short sections. However, only 33.3% said that the video's sections have informative headers. All the experts agreed that the video presents information in a logical sequence and allows the user to hear the words clearly (not too fast or garbled). A total of 83.3% said that the video uses visual cues (arrows, boxes, bullets, bolds, a larger font, and highlighting) to draw attention to key points, and the text on the screen is easy to read. Two-thirds said that the video provides a summary, uses illustrations and photographs that are clear and uncluttered, and uses simple tables with short and clear row and column headings.

For actionability evaluation, all the experts agreed that the video clearly identifies at least one action the user can take, addresses the user directly when describing actions, and breaks down any action into manageable, explicit steps. Only 66.7% said that the video explains how to use charts, graphs, tables, or diagrams to take actions. This shows that both understandability and actionability are in the acceptable range.

The understandability evaluation has a maximum possible score of 78 points (100%). The video received 63 points (80%) for understandability. On the other hand, the maximum score for the actionability evaluation is 24 points (100%). The nutritional education video receives an actionability score of 22 (92%).

A subsample of the target viewers was invited to watch the newly developed video and answer an online survey which consisted of the Malay version of the PEMAT-A/V tool (Saddki et al., 2018). A total of 30 women aged 18 to 45 years, all of whom were Malay, participated in the study. Annexure 3 depicts their responses regarding the understandability and actionability of the video.

Regarding understandability, all participants said that the video makes its purpose completely evident, breaks or "chunks" information into short sections, and allows the user to hear the words clearly (not too fast, not garbled). On the other hand, 93.3% agreed that the video presents information in a logical sequence, the text on the screen is easy to read, and it uses illustrations and photographs that are clear and uncluttered. The same 93.3% also said that the video provides a summary, the text on the screen is easy to read, and this video uses illustrations and photographs that are clear and uncluttered. In addition, 90% said that the video uses common, everyday language, that the video's sections have informative headers, and that the video provides a summary. A total of 86.7% of them concurred that the video primarily uses medical terms to acquaint the audience with their definitions, employs visual cues such as arrows, boxes, bullets, bolds, larger fonts, and highlighting to highlight key points, and employs simple tables with concise and clear row and column headings. Lastly, 83.3% said that the video uses active voice.

In terms of actionability, 100% agreed that the video clearly identifies at least one action the user can take and addresses the user directly when describing actions. 96.7% said that the video breaks down any action into manageable, explicit steps. Only 76.7% said that the video explains how to use charts, graphs, tables, or diagrams to take actions.

The maximum possible score for the understandability evaluation is 390 points (100%). The nutritional education video achieved a score of 358 points (92%). Out of the 120 points, which is the maximum possible score for actionability, the video obtained 112 points (93%).

Discussion:

The current study aimed to develop and evaluate an animated video on the recommended total calorie intake and healthy weight gain during pregnancy to minimise child stunting prevalence in this country. Maternal nutrition during pregnancy has a big impact on the health of the mother as well as her foetus. Inadequate intake of nutrients of good quality and quantity would lead to health problems for both the mother and the baby. While there are many consequences to the health of the mother, the baby could be affected by low birth weight, intrauterine growth retardation, and stunting while growing up (Salem et al., 2016).

Ensuring the healthy development of the foetus and maintaining the mother's health during pregnancy requires healthy nutrition, which provides adequate calories to allow for appropriate weight gain. According to the Ministry of Health Malaysia, underweight mothers should gain between 12 and 18 kg, normal-weight mothers should gain between 11 and 16 kg, and overweight mothers should gain between 7 and 11 kg (Kusiar, 2017). During pregnancy, energy requirements are increased due to the increase in tissue masses in the foetus and placenta, basal metabolic rates, and changes in the energy cost of physical activity (NCCFN, 2017). The first trimester requires an extra 80 kcal per day, the second trimester requires an extra 280 kcal per day, and the third trimester requires an extra 470 kcal per day (NCCFN, 2017).

With the introduction of new technologies, healthcare professionals can now share knowledge with the public in novel ways that spark interest and improve learning. There is also evidence that the use of different formats to communicate health information to patients, including the Internet, CD-ROM, video, audio recordings, and text messages, is often more effective than conventional health communication. Although traditional written information might improve health knowledge and information recall, alternative format resources have been shown to produce better health knowledge, user satisfaction, self-efficacy, and health behaviour (Berkman et al., 2004).

Systematic reviews have demonstrated that video-based educational methods are potentially effective for encouraging behaviour change (Weidmann et al.,

2023; Tuong, Larsen & Armstrong, 2014). Compared to other media, video offers advantages such as facilitating group viewing, standardising information, allowing for repeated viewing at one's convenience, and effectively explaining concepts that are challenging to convey in written form. There are three different types of video-based educational intervention formats: animated presentations, professionals in practice, and patient narratives (Dahodwala et al., 2018). Among these, the animated format has some advantages compared to others, as it does not require actors or camera equipment. It also allows the addition, removal, or modification of content relatively easily, and this flexibility is central to accommodating the dynamism of health information (Dahodwala et al., 2018).

With regards to suitability, most of the respondents in the current study agreed that the purpose of the educational video was not explicit. Providing a title at the beginning of the video could improve the clarity of the purpose for some of the respondents. This is important, as the viewers need to understand the intended purpose of the nutritional education video. Nearly all the respondents agreed that the essence of the video is the application of knowledge or skills aimed at desirable reader behaviours rather than non-behaviour facts. Adult patients often want to solve their immediate health issue rather than learning the medical facts, and the content of utmost interest and use to patients is likely to be behaviour information in helping them to resolve their problem (Doak et al., 1996). The types of graphics used in the video are agreed upon by most of the respondents to be simple, adult-appropriate, and familiar to the viewers. This is in line with the findings by Clayton (2010) that it is helpful to use graphics as assistance for patients to understand more clearly.

In terms of understandability and actionability, all the respondents agreed that the video allows them to hear the words clearly, and the video uses illustrations and photographs that are clear and uncluttered. It was found that the use of visual aids in nutrition education and intervention increased awareness among the public (Yata & Habib, 2018). A large proportion of the respondents agreed that the video clearly identifies at least one action the user can take. This is in line with a study conducted by Kakunted (2008), which emphasised that the concentration on the practical application of nutrition education material should be increased for effectiveness other than reinforcing and monitoring the adequacy of knowledge. Silk et al. (2008) found that nutrition education plays a crucial role in addressing deficits in nutrition knowledge. In fact, maternal knowledge and attitude can be enhanced with appropriate nutrition education interventions (Guldan et al., 2000).

This is the first animated video to educate mothers regarding healthy total energy intake and gestational weight gain during pregnancy to prevent the prevalence of child stunting ever produced. Its development and evaluation processes were based on a guided study design. Evaluations by experts in nutrition and dietetics, along with a subsample of childbearing-aged women recently pregnant, contributed positively to the study's strength. However, the study was not without its limitations. The COVID-19 pandemic restricted participant recruitment among the target population for the current study. Despite conducting the data collection online for convenience, the response rate remained slow. Constant reminders were needed to urge the respondents to complete the questionnaire.

Conclusion:

This research aimed to develop and evaluate a nutritional education video on recommended total calorie intake and healthy weight gain during pregnancy. Experts and a subsample of the target viewers evaluated the suitability, understandability, and actionability of the newly developed nutritional education video, concluding that it is suitable for use and has an acceptable level of understandability and actionability. This indicates the animated video's potential as a nutrition education tool to deliver nutritional knowledge to pregnant mothers and prevent stunting prevalence in their children.

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Supplementary Document:

Development & evaluation of an animated video on healthy weight gain and energy intake during pregnancy for stunting prevention

Annexure 1. Suitability evaluation by experts (N=6)

Items	Score	Frequency (%)
Purpose of the video		
- The purpose is explicitly stated in title, or cover illustration, or introduction.	2	2 (33.3%)
- The purpose is not explicit. It is implied, or multiple purposes are stated.	1	4 (66.7%)
- No purpose is stated in the title or cover illustration or introduction.	0	0 (0%)
Content about behaviours		
- The essence of the material is application of knowledge/ skills aimed at desirable reader behaviours rather than nonbehaviour facts.	2	6 (100%)
- At least 40 percent of content topics focus on desirable behaviours or actions.	1	0 (0%)
- Nearly all topics are focused on non-behaviour facts.	0	0 (0%)
Scope of the video		
- The scope is limited to and focused on essential information directly related to the purpose. Experience shows it can be learned in time allowed.	2	6 (100%)
- The scope is expanded beyond the purpose; no more than 40 percent is nonessential information. Key points can be learned in time allowed.	1	0 (0%)
- The scope is far out of proportion to the purpose and time allowed.	0	0 (0%)
Summary of the video included		
- Summary is included and retells the key messages in different words and examples.	2	0 (0%)
- Some key ideas are reviewed.	1	4 (66.7%)
- No summary or review is included.	0	2 (33.35)
Vocabulary used		
- All three factors; i) Common words are used nearly all of the time, ii) Technical, concept, category, value judgement (CCVJ) words are explained by examples, iii) Imagery words are used as appropriate for content.	2	2 (33.3%)
- i) Common words are frequently used, ii) Technical and CCVJ words are sometimes explained by examples, iii) Some jargon or math symbols are included	1	2 (33.3%)
- Two or more factors; i) Uncommon words are frequently used in lieu of common words, ii) No examples are given for technical and CCVJ words, iii) Extensive jargon	0	2 (33.3%)
Type of graphics		
- Both factors; i) Simple, adult-appropriate, line drawings/ sketches are used, ii) Illustrations are likely to be familiar to the viewers.	2	6 (100%)
- One of the superior factors is missing	1	0 (0%)
- None of the superior factors are present	0	0 (0%)
Relevance of illustrations		

- Illustrations present key messages visually so the reader/ viewer can grasp the key ideas from the illustrations alone. No distractions.	2	4 (66.7%)
- i) Illustrations include some distractions, ii) Insufficient use of illustrations	1	2 (33.3%)
- One factor; i) Confusing or technical illustrations (non-behaviour related), ii) No illustrations, or an overload of illustrations.	0	0 (0%)
Lists and tables explained		
- Step-by-step directions, with an example, are provided that will build comprehension and self-efficacy.	2	2(33.3%)
- "How-to" directions are too brief for readers to understand and use the graphics without additional counseling.	1	4 (66.7%)
- Graphics are presented without explanation.	0	0(0%)
Captions used for graphics		
- Explanatory captions with all or nearly all illustrations and graphics.	2	4 (66.7%)
- Brief captions used for some illustrations and graphics.	1	2 (33.3%)
- Captions are not used.	0	0 (0%)
Match in logic, language, experience (LLE)		
- Central concepts/ ideas of the material appear to be culturally similar to the LLE of the target audience's culture.	2	2 (33.3%)
- Significant match in LLE for 50 percent of the central concepts.	1	4 (66.7%)
- Clearly a cultural mismatch in LLE	0	0 (0%)

Annexure 2. Understandability and actionability evaluation by experts (N=6)

Item	Frequency (%)
Understandability	
This video makes its purpose completely evident.	
- Agree	6 (100%)
- Disagree	0 (0%)
This video uses common, everyday language.	
- Agree	5 (83.3%)
- Disagree	1 (16.7%)
Medical terms are used only to familiarize the audience with the terms. When used, medical terms are defined.	
- Agree	6 (100%)
- Disagree	0 (0%)
This video uses the active voice.	
- Agree	6 (100%)
- Disagree	0 (0%)
This video breaks or "chunks" information into short sections.	
- Agree	4 (66.7%)
- Disagree	2 (33.3%)
This video's sections have informative headers.	
- Agree	2 (33.3%)
- Disagree	4 (66.7%)
This video presents information in a logical sequence.	
- Agree	6 (100%)
- Disagree	0 (0%)
This video provides a summary.	

- Agree	4 (66.7%)
- Disagree	2 (33.3%)
This video uses visual cues (e.g., arrows, boxes, bullets, bolds, larger font, highlighting) to draw attention to key points.	
- Agree	5 (83.3%)
- Disagree	1 (16.7%)
The text on the screen is easy to read.	
- Agree	5 (83.3%)
- Disagree	1 (16.7%)
This video allows the user to hear the words clearly (e.g., not too fast, not garbled).	
- Agree	6 (100%)
- Disagree	0 (0%)
This video uses illustrations and photographs that are clear and uncluttered.	
- Agree	4 (66.7%)
- Disagree	2 (33.3%)
The video uses simple tables with short and clear row and column headings.	
- Agree	4 (66.7%)
- Disagree	2 (33.3%)
Actionability	
This video clearly identifies at least one action the user can take.	
- Agree	6 (100%)
- Disagree	0 (0%)
This video addresses the user directly when describing actions.	
- Agree	6 (100%)
- Disagree	0 (0%)
This video breaks down any action into manageable, explicit steps.	
- Agree	6 (100%)
- Disagree	0 (0%)
The video explains how to use the charts, graphs, tables, or diagrams to take actions.	
- Agree	4 (66.7%)
- Disagree	2 (33.3%)

Annexure 3 Understandability and actionability evaluation among a target population (N=30)

Item	Frequency (%)
Understandability	
This video makes its purpose completely evident.	
- Agree	30 (100%)
- Disagree	0 (0%)
This video uses common, everyday language.	
- Agree	27 (90%)
- Disagree	3(10%)
Medical terms are used only to familiarize audience with the terms. When used, medical terms are defined.	
- Agree	26 (86.7%)
- Disagree	4 (13.3%)
This video uses the active voice.	
- Agree	25 (83.3%)
- Disagree	5(16.7%)

This video breaks or "chunks" information into short sections.	
- Agree	30 (100%)
- Disagree	0 (0%)
This video's sections have informative headers.	
- Agree	27 (90%)
- Disagree	3(10%)
This video presents information in a logical sequence.	
- Agree	28 (93.3%)
- Disagree	2 (6.7%)
This video provides a summary.	
- Agree	27 (90%)
- Disagree	3(10%)
This video uses visual cues (e.g., arrows, boxes, bullets, bolds, larger font, highlighting) to draw attention to key points.	
- Agree	26 (86.7%)
- Disagree	4 (13.3%)
The text on the screen is easy to read.	
- Agree	28 (93.3%)
- Disagree	2 (6.7%)
This video allows the user to hear the words clearly (e.g., not too fast, not garbled).	
- Agree	30 (100%)
- Disagree	0 (0%)
This video uses illustrations and photographs that are clear and uncluttered.	
- Agree	28 (93.3%)
- Disagree	2 (6.7%)
The video uses simple tables with short and clear row and column headings.	
- Agree	26 (86.7%)
- Disagree	4 (13.3%)
Actionability	
This video clearly identifies at least one action the user can take.	
- Agree	30 (100%)
- Disagree	0 (0%)
This video addresses the user directly when describing actions.	
- Agree	30 (100%)
- Disagree	0 (0%)
This video breaks down any action into manageable, explicit steps.	
- Agree	29 (96.7%)
- Disagree	1 (3.3%)
The video explains how to use the charts, graphs, tables, or diagrams to take actions.	
- Agree	23 (76.7%)
- Disagree	7 (23.3%)

Prevalence and Severity of Neck Pain and its Association with Smartphone Addiction among Undergraduate Students at the Kulliyyah of Allied Health Sciences (KAHS), IIUM Kuantan

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Abstract:

Introduction: The prevalence of neck pain associated with smartphone addiction among students is rising with advancing technology. Excessive smartphone use leads to musculoskeletal disorders that can impair daily functional ability. This study aimed to determine the prevalence of smartphone addiction and neck pain affecting functional activities among undergraduate students at KAHS, IIUM Kuantan Campus, and to examine the relationship between neck pain and smartphone addiction. **Methodology:** A cross-sectional study was conducted with 105 undergraduate students. Smartphone addiction and neck pain were assessed using the Smartphone Addiction Scale Short Version (SAS-SV) and the Neck Disability Index (NDI) questionnaire. The questionnaire was distributed online through convenient sampling. **Results:** The prevalence of smartphone addiction was 41.9%, and neck pain affecting functional ability was 50.5%. Spearman correlation analysis revealed a weak positive correlation ($r = 0.385$) between smartphone addiction and neck pain, with a significance level of $p<0.001$. **Conclusion:** This study concludes that excessive smartphone use is significantly associated with neck pain and disability. Assessing the prevalence among university students may increase awareness of neck pain and support the implementation of preventive measures to reduce the risk of disability caused by neck pain.

Keywords: neck pain, smartphone addiction, musculoskeletal disorders, undergraduate students

Introduction:

Musculoskeletal problems affect approximately 1.71 billion people worldwide, encompassing disorders that impact muscles, bones, joints, and connective tissues (World Health Organization, 2022). Kazeminasab et al. (2022) reported that about 2.7% of the global population experienced neck pain in 2019. Data from the Global Burden of Disease shows that while the prevalence of neck pain has remained steady, its incidence and the years lived with disability remain significantly high (Shin et al., 2022). Although the prevalence of neck pain in Malaysia is relatively low at 3.0%, it has increased by 100% over the past 29 years (Shin et al., 2022).

The Handphone Users Survey 2021 by the Malaysian Communications and Multimedia Commission (MCMC) revealed that approximately 94.8% of Malaysians are active smartphone users, and 95.7% of Malaysian students own at least one smartphone. The survey also observed a significant rise in smartphone usage among Malaysians, jumping from 15.1% to 91.5% in three years. The highest

percentage of smartphone users, 93.6%, is among individuals aged 20 to 34. This high usage rate among young adults puts them at risk of developing smartphone addiction and neck pain. Isa et al. (2022) found that over half of local undergraduate students (53.6%) are at risk of neck pain. Hua et al. (2022) reported that neck disorders related to smartphone addiction are the most prevalent musculoskeletal issues among Malaysians, with a prevalence of 65.9%.

The rapid increase in smartphone users has raised concerns about the health impacts of smartphone addiction, particularly on musculoskeletal health. Several studies have shown that smartphone addiction can significantly affect neck health (Hua et al., 2022; Kazeminasab et al., 2022). Neck pain is a multifactorial condition, with prolonged computer and smartphone use being significant risk factors (Jahre et al., 2020; Gao et al., 2023.). The abnormal neck flexion required to view a smartphone can reduce the normal cervical lordosis, increasing stress on the neck's muscles, ligaments, and vertebrae (Sirajudeen et al., 2022; David et al., 2021).

A study published in the International Journal of Health Sciences found that 73.5% of university students in Malaysia were at risk of developing smartphone addiction, and 65.9% reported neck pain (Hua et al., 2022). Given these findings, this study aims to investigate the relationship between smartphone addiction and neck pain among undergraduate students at the Kulliyyah of Allied Health Sciences (KAHS) at IIUM Kuantan Campus.

Methodology:

After receiving ethical approval from the Kulliyyah Postgraduate and Research Committee (KPGRC ID NO.: KAHS 96/23) a cross-sectional study was conducted among KAHS undergraduate students with no history of musculoskeletal problems who had been using a smartphone for at least one year. A self-administered questionnaire was distributed via social media platforms which consisted of two parts:

Part A: Collection of participants' sociodemographic data including age, gender, year of study and department.

Part B: A validated structured questionnaire comprising the (i) Smartphone Addiction Scale-Short Version (SAS-SV) to assess smartphone addiction based on factors such as daily-life disturbance, positive anticipation, withdrawal, cyberspace-oriented relationships, overuse, and tolerance (Kwon et al., 2013) and (ii) Neck Disability Index (NDI) to evaluate neck pain affecting daily life, requiring participants to self-rate their ability to manage activities such as personal care, lifting, reading, headaches, concentration, work status, driving, sleeping, and recreation (Vernon, 2008). The SAS-SV cut off value for smartphone addiction varied by genders which is set at 31 or more for males and 33 or more for females. As for the NDI, the questionnaire was scored using 0-5 points with the maximum total score for 10 items is 50 points. The interpretation of NDI is based on the total score of 0 to 50 with five disability neck classifications ranging from no disability, mild, moderate, severe to complete disability.

Demographic data were analysed using descriptive statistics. The Chi-square test was used to evaluate the association between demographic data and neck disability, and the Spearman Correlation test assessed the relationship between smartphone addiction and the neck disability index.

Results:

A total of 105 students aged 19 to 25 years, with a mean age of 20.67 (±1.21), participated in this study. Among them, 82.9% were female. Most students (61.9%) spent more than 6 hours daily on smartphones. Of the participants, 41.9% met the criteria for smartphone addiction, while 58.1% did not. The demographic data can be referred in Table 1.

Half of the participants (50.5%) reported some level of neck functional disability. Among them, 43.8% experienced mild disability, and 6.7% had moderate disability. The remaining 49.5% reported no disability related to neck pain. Notably, no participants reported severe or complete disability. Figure 1 presents a bar chart of neck functional disability among KAHS students.

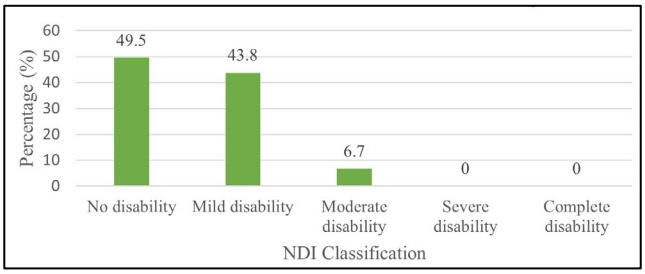

Figure 1: Prevalence of neck disability affecting daily life.

Table 1 : Demographic and time spent on smartphones among the KAHS undergraduate students at IIUM Kuantan Campus (n= 105)

Variable	Mean (SD*)	N (%)
Age (years)	20.67 (1.21)	
Gender		
Male		18(17.1)
Female		87 (82.9)
Year of Study		
First year		28 (26.7)
Second year		24 (22.9)
Third year		26 (24.8)
Fourth year		27 (25.7)
Department		
DNS		20 (19)
DBMS		20 (19)
DOVS		17 (16.2)
DDIR		10 (9.5)
DPRS		25 (23.8)
DASLP		13 (12.4)
Average time spent using smartphones		
<3 hours per day		4 (3.8)
4-5 hours per day		36 (34.3)
>6 hours per day		65 (61.9)
Smartphone Addiction		
Smartphone addict		44 (41.9)
Non-smartphone addiction		61 (58.1)

*SD = Standard Deviation **N = Numbers
DNS: Department of Nutritional Sciences, DBMS: Department of Biomedical Sciences, DOVS: Department of Optometry and Visual Sciences, DDIR: Department of Diagnostic Imaging and Radiography, DPRS: Department of Physical Rehabilitation Sciences, DASLP: Department of Audiology and Speech-Language Pathology

Association Between Neck Disability and Demographic Data

Table 2 demonstrates the association of functional neck disability and demographic data. This study found that females predominantly experienced neck functional disability. First-year students accounted for the highest proportion (41.5%) of those with neck disability, while most participants without neck disability were fourth-year students (34.6%).

Surprisingly, among those 52 participants with no neck disability, 55.8% of them reported no neck disability despite spending more than 6 hours daily using the smartphones. While those with neck disabilities, 67.9% reported using smartphones for more than six hours daily.

Correlation Between Smartphone Addiction and Level of Neck Pain Affecting Daily Life

Utilizing the NDI questionnaire, it was determined that 44 students (41.9%) were classified as smartphone addicts. Among these, 38.6% exhibited no neck disability, 50.1% experienced mild neck disability, and 11.3% had moderate neck disability, with no instances of severe or complete neck disability. In comparison, of the 61 non-addicted students, 57.4% had no neck disability, 39.3% reported mild neck disability, and 3.3% experienced moderate neck disability, also with no cases of severe or complete neck disability. These findings suggest a higher prevalence and severity of neck pain among students with smartphone addiction. Data on the frequency and percentage of each level of neck pain affecting daily life is shown in Table 3.

The relationship between the score of the Smartphone Addiction Scale-short version and the score of the NDI was assessed using the Spearman's rank-order correlation. It was found that there was a weak correlation between smartphone addiction level (SASSV) and neck disability index (NDI) in the population $r = 0.385$, $n = 105$, $p<0.001$

Table 2 : Association of functional neck disability and demographic data

Variable	Disability n (%)		Chi-square statistic (df)**	p-value
	No disability	Disability		
Gender				
Male	11 (21.2)	7 (13.2)	1.167	0.311
Female	41 (78.8)	46 (86.8)	(1)	
Year of study				
Year 1	6 (11.5)	22 (41.5)	12.917	0.004*
Year 2	13(25.0)	11 (20.8)		
Year 3	15(28.8)	11 (20.8)		
Year 4	18 (34.6)	9 (17.0)		
Time spent using smartphone				
<3 hours daily	3 (5.8)	1 (1.9)	2.119	0.326
4-5 hours daily	20 (38.5)	16 (30.2)	(2)	
>6 hours daily	29 (55.8)	36 (67.9)		

(*) indicates significant difference at $p < 0.05$ **df = degree of freedom

Table 3 : Descriptive statistic between level of smartphone addiction and severity of neck pain (n=105)

Variable	Neck Disability Index (NDI) n (%)				
	No disability	**Mild disability**	**Moderate disability**	**Severe disability**	**Complete disability**
SASSV					
Smartphone addiction	17 (38.6)	22 (50.1)	5 (11.3)	0 (0.0)	0 (0.0)
No smartphone addiction	35 (57.4)	24 (39.3)	2 (3.3)	0 (0.0)	0 (0.0)

Discussion:

Prevalence of Neck Pain on Functional Disability

This study reveals that 41.9% of KAHS undergraduate students are smartphone addicts, a figure higher than the 37.1% prevalence reported in a local study (Lee et al., 2023) and the global estimated prevalence of 27% (Meng et al., 2022). The higher risk of smartphone addiction among students may be attributed to internet use, social media, and gaming. Additionally, a significant portion of participants reported spending extensive time on their smartphones daily, which can increase the likelihood of developing an addiction (Isa et al., 2022).

It was also found that 50.5% of participants experienced neck pain affecting their daily lives, while 49.5% did not report this problem. A local study conducted by Isa et al. (2022) reported a neck pain prevalence of 53.6% among undergraduate students, showing a similar local prevalence. However, compared to other countries, the prevalence of neck pain is 36.7% among health sciences students in Ethiopia (Wami et al., 2021) and 17.5% in China (Chan et al., 2020), which is considerably lower. Therefore, it can be concluded that the prevalence of neck pain affecting functional ability is high among undergraduate students at KAHS IIUM. This high prevalence can be attributed to several factors such as students at KAHS IIUM might face vigorous academic demands requiring prolonged study that could lead to poor posture and neck strain and lack of physical activity due to busy schedule that leave little time for exercise, causing weakening of muscles supporting the neck (Gao et al., 2023).

A review by Galit and Felix (2021) found that the neck is the most reported site of pain among college students, indicating that neck discomfort is common and may impact daily life. Kazeminasab et al. (2022) categorized the risk factors for neck pain into psychological and biological factors. Undergraduates are particularly susceptible to neck pain related to psychological factors, including anxiety, stress, depression, and sleep problems, which are prevalent during university life. Additionally, work-related factors, particularly poor ergonomics while working, contribute to neck pain. Students may develop computer-related neck pain due to poor ergonomic posture, prolonged computer use, psychological stress, repetitive neck movements, and prolonged static strain on the neck musculature.

Association Between Demographic Factors and Neck Pain

A review by Gupta et al. (2019), Kazeminasab et al. (2022), Gao et al. (2023.), and Jahre et al. (2020) identified several risk factors associated with neck pain. Unmodifiable risk factors include gender and year of study, with several reviews indicating that being female and having more years of study increases the risk of developing neck pain. Modifiable risk factors include smartphone usage time, while the type of degree program was not found to be a risk factor. This study found no significant association between gender and neck pain. A higher proportion of female students were in the functionally disabled group. However, it should be noted that the total number of female participants outnumbered the male participants. Previous research (Shin et al., 2022; Abdel et al., 2023) supports that females are more prone to neck pain, likely due to lower pain thresholds and muscle strength compared to males. Kazeminasab et al. (2022) reported an ambiguous association between sex and neck pain, indicating the need for further meta-analysis.

This study found a significant association between the year of study and functional neck disability ($p = 0.004$). Surprisingly, the highest percentage of neck disability was among first-year students (41.5%), while final-year students had the lowest percentage (17%). This contrasts with Chan et al. (2020) and Wami et al. (2021), who found increasing prevalence with more years of study. The high prevalence of neck disability among first-year

students might be explained by the stress of adjusting to university life. Salam et al. (2013) explained that first-year Malaysian students experience significant academic-related stress. Stress, a known risk factor for neck pain, can affect students across all years if they cannot cope effectively.

This study also found no significant association between the duration of smartphone use and neck pain affecting functional ability ($p = 0.326$). This contrasts with Mustafaoglu et al. (2021), who reported a high association between smartphone use over six hours daily and neck disorders. The lack of association in this study may be attributed to students' awareness of ergonomic posture and different usage patterns, such as frequently changing positions while using their smartphones. Apart from that, participants may have underreported their symptoms or overestimated their ergonomic practices due to social desirability bias.Further studies are needed to explore the relationship between smartphone use and neck pain and to investigate effective preventive measures.

Correlation Between Smartphone Addiction and Neck Pain

Mustafaoglu et al. (2021) and Hua et al. (2022) reported a correlation between musculoskeletal disorders, particularly neck pain, and smartphone addiction. Both studies indicated that neck pain is among the most prevalent complaints among smartphone users. A study by Suresh et al. (2021) using both the SAS-SV and NDI on 88 university students in India found a moderate positive correlation between smartphone addiction and neck pain. Another study with a larger sample size of 501 university students in Turkey also found a positive correlation, albeit a low one (Badil Güloğlu & Yalçın, 2021).

This study similarly found a weak positive correlation between smartphone addiction and neck disability ($r = 0.385$, $n = 105$, $p < 0.001$). This may be due to participants adopting better ergonomic practices, which could mitigate the impact of smartphone addiction on neck disability. Additionally, variations in lifestyle, academic pressures and daily activities can influence the relationship between smartphone addiction and neck pain, resulting in a weaker association. Neck disability among smartphone users is often related to "text neck," a condition caused by prolonged non-ergonomic postures while using smartphones. Smartphone addicts are particularly prone to this condition due to the extensive time they spend on their devices and the repetitive neck movements toward the screen (Chovatiya et al., 2021). This routine can injure the neck musculature and surrounding soft tissue (AlAbdulwahab et al., 2017).

Conclusion:

This study highlights the importance of raising awareness about the physical risks associated with excessive smartphone use among undergraduate students. There was a significant correlation between smartphone addiction and neck pain, which affects functional abilities. The prevalence of both smartphone addiction and neck pain is notably high among KAHS IIUM students.

The findings suggest a potential link between smartphone addiction and neck pain, which may be associated with functional disability. Poor ergonomic posture while using mobile devices is identified as the main cause of neck pain among smartphone users. To address this, health education programs and interventions should be actively implemented to reduce the risk of musculoskeletal issues caused by excessive smartphone use. Preventive measures should include managing smartphone usage and promoting ergonomic body posture. Students should be encouraged to develop good habits when using smartphones to minimize the risk of musculoskeletal disorders.

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Metagenomic Analysis of Contaminated Lift Buttons Reveals Prevalent Pathogens with Antimicrobial Resistance Genes: A Study in a Public Hospital in Pahang, Malaysia

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Abstract:

Introduction: Hospital lift buttons are potential reservoirs for microbial contamination, contributing to the transmission of hospital-acquired infections (HAIs). Despite routine cleaning efforts, concerns persisted regarding the prevalence of contaminants on these surfaces, particularly in healthcare settings within Southeast Asian countries. This study aimed to investigate the prevalence and microbial diversity of contaminants on lift buttons in a public hospital (PH) located in Pahang, Malaysia, during the coronavirus disease 2019 pandemic. **Methods:** Purposive swab sampling was conducted thrice at two-week intervals. Standard plate count and metagenomic analysis were employed to determine the prevalence of contaminants and identify the diverse microbial communities, respectively. Analysis of variance and Bonferroni test evaluated at alpha value less or equal to 0.05, were performed to determine the significance of the findings. **Results:** The investigation revealed a notable prevalence of contaminants at 30.4% on both interior and exterior lift buttons, with no significant disparity observed between lifts in high-risk and moderate-risk areas ($p>0.05$). Metagenomic analysis revealed Firmicutes as the dominant phylum, with *Staphylococcus* and *Bacillus* being the most prevalent genera. Analysis of the Kyoto Encyclopaedia of Genes and Genomes (KEGG) pathways highlighted the importance of ABC transporter and two-component systems, where key genes involved in the iron complex transport, antimicrobial resistance, and multidrug efflux enriched, crucial for the microbial survival. **Conclusion:** These findings underscored the complexity of microbial ecosystems and

their adaptive mechanisms in response to environmental pressures, while emphasizing the importance of implementing effective infection control measures to mitigate the risk of lift buttons-associated HAIs. Future research should broaden the geographical scope to encompass diverse hospital settings and explore the interaction of microbial communities' functional capabilities with the hospital environment, offering insights into optimizing hygiene practices and targeted intervention.

Keywords: lift button, hospital, KEGG, metagenomic, antimicrobial resistance genes, hospital-acquired infection

Introduction:

Lift in healthcare facilities stand as indispensable conduits of vertical mobility, facilitating the transportation of patients, medical staff, and essential resources. Despite their significance, lifts, as one of the high-touch surfaces, often go unnoticed as potential vectors of microbial contamination, silently contributing to the transmission of infectious agents within hospitals. Hospital-acquired infections (HAIs) are persistent challenges in healthcare settings, often caused by various pathogens, including those found on lift buttons.

The emergence of HAIs is not a recent concern, as this issue has been globally prevalent since the 1900s. A study conducted by Goh et al. (2023) revealed that the prevalence of HAIs in Southeast Asian countries stood at 22% between 1990 and 2022, reaching the upper limit of the worldwide HAI rate (7-22%) reported by WHO (Kilpatrick et al., 2011). WHO's data in year 2022 highlighted that the infection rate for HAIs was one in 100 patients in low- and middle-income countries, with an average mortality rate of one in every ten affected patients (WHO, 2022).

The source of HAIs extends beyond the well-known ESKAPE pathogens, namely *Enterococcus faecium, Staphylococcus aureus, Klebsiella pneumoniae, Acinetobacter baumannii, Pseudomonas aeruginosa*, and *Enterobacter* spp. Additional pathogens have been recognized in patients with HAIs, many of whom develop pathogenicity due to compromised immune systems (AMBOSS, 2020). Various risk factors contribute to these infections, including, but not limited to, age (particularly over 70 years old), extended hospital stays, antibiotic usage, and metabolic diseases (AMBOSS, 2020). HAIs are often associated with specific conditions such as central line-associated bloodstream infection, catheter-associated urinary tract infection, surgical site infection, and ventilator-associated pneumonia, which are among the most prevalent causes of these infections (CDC, 2014).

Lift buttons are not excluded from being contaminated with agents responsible for HAIs. A study conducted in Tehran, Iran, discovered the presence of methicillin-resistant *S. aureus* on hospital lift buttons (Abbasian et al., 2018). Similarly, research in China revealed the isolation of carbapenem-resistant *A. baumannii* on lift buttons (Liu et al., 2017). Despite hospitals implementing thorough cleaning protocols to combat HAIs, the reduction in HAI trends across Southeast Asian countries from 1990-2014 to 2014-2022 was marginal, with only 0.01% (Goh et al., 2023). This percentage poses a challenge to healthcare departments, suggesting potential shortcomings in disinfection techniques and cleaning routines.

Understanding the microbial contamination of lift buttons is crucial for infection control measures, given their frequent use due to the constant flow of individuals, numerous touchpoints and enclosed space (Gooch and Wadhwa, 2020). Particularly in Southeast Asian countries, most studies conducted in hospital environments are more focused on clinical samples, leaving a gap in the study of fomites like lift buttons, (Sani et al., 2014; Sukri et al., 2022).

Recognizing the need to address this gap, the study embarked on an exploration of the prevalence and metagenomic profiles of microbial contamination on the lift buttons of a public hospital (PH) in Pahang, Malaysia, a country with a standard ideal population (Department of Statistics Malaysia, 2022). The objectives encompass analysing the prevalence of contaminants and understanding the dominance patterns and the survival capabilities of varies microbial species harbouring hospital lift buttons. By delving into the intricacies of lift button contamination, the study aimed to contribute valuable insights to fortify infection control strategies in regional healthcare settings. This investigation served

as a critical step towards understanding and mitigating the potential infectious threats present in a hospital infrastructure.

Methodology:

Study Location

The public hospital was located in a coastal and urban environment in Pahang. The hospital, one of the largest healthcare facilities in the region, had over 500 beds with more than 50% bed occupancy rates. It consisted of more than 20 different departments and units. The hospital served a diverse population from both urban and rural areas by providing a range of healthcare services, from primary care to specialized treatments and outpatient services (Mahdi Yahya Mohsen et al, 2016).

Sampling Procedure

This study focused on evaluating the microbial contamination of hospital lift buttons under defined parameters. Eligible lifts included those accessible to all patient floors with a dimension that could fit a standard hospital bed, excluding lifts transporting COVID-19 related matters. Systematic selection of lift buttons centred around floors or areas with documented reports of contaminants, encompassing main entrances (ME, floor G), operation theatres (OT, floor 3), intensive care units (ICU, floor 3), paediatric wards (PW, floor 6), and general wards (GW, floor 8) (De Paula Menezes et al., 2022; Doughty et al., 2022; Olise and Simon-Oke, 2018).

The sampling process used the technique adapted from Carrascosa et al. (2018), where a cotton swab moistened with 1mL of 0.1% peptone water (Merck, Germany) was used along a 14 cm^2 stencil for 10 seconds. The collection of control samples was implemented after disinfecting the lift buttons with 70% ethanol. A collection of 100 lift buttons, including both interior (horizontal and vertical panels) and exterior buttons was obtained in a single sampling procedure (Figure 1). The sampling process was conducted three times at two-week intervals during the COVID-19 Movement Control Order (March-April 2021).

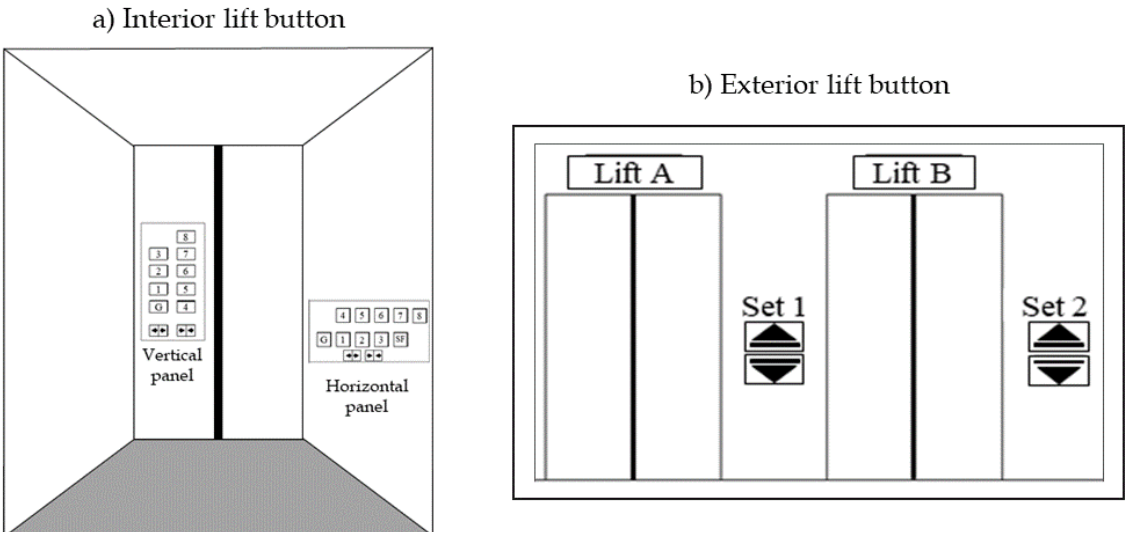

Figure 1: Location of interior (vertical and horizontal panels) and exterior lift buttons. The vertical panel is situated within the lift beside the door, whereas the horizontal panel is positioned on the side of the lift, closer to the bottom. Exterior lift buttons are arranged in sets, typically consisting of an up button and a down button.

Standard Plate Count

A 10 µL aliquot was aliquoted and spread evenly on the surface of nutrient agar plates and incubated for 24-48 hours at 37°C (Elsergany et al. 2015; Mohd Fauzi, 2018). The prevalence of bacteria and colony forming units per millilitre (CFU/mL) were calculated using the formula from the Glasgow et al. (2013) and Appeh et al. (2022), respectively. The analysis of variance (ANOVA) test was used to measure the association between lifts, lift buttons panels and the selected floors, while the Bonferroni test was used as a post hoc test. Statistical analysis of the data was performed using Statistical Package for the Social Sciences (SPSS) software version 27.0, where the analyses were evaluated at an alpha value less or equal to 0.05.

Metagenomic Analysis

Similar volume of samples was aliquoted and pooled into 10 mL of tryptic soy broth (Merck, Germany). The tubes were incubated at 37°C with aeration of 200 rpm for 24-40 hours (Valeriani et al., 2018), followed by pelleting down at 13,100 x g for 5 minutes and removing the supernatant. The genomic DNA of the samples was performed using DNeasy® UltraClean® Microbial Kit by Qiagen (Hilden, Germany) according to the manufacturer's instructions. The quality and quantity of the extracted DNA were evaluated through gel electrophoresis using 1% agarose gel (Vivantis, Malaysia) and spectrophotometer readings.

DNA samples with concentration of >45ng/µL were sequenced using the Oxford Nanopore Technologies (ONT) MiNION flowcell for long reads, following the manufacturer's instructions (Oxford Nanopore, United Kingdom). The data obtained in raw fast5 files were subjected to base-called in high accuracy mode using Guppy v 4.4.1. The reads obtained were filtered based on their quality and read length to ensure a longer read with qscore of 7 and above. The reads were assembled using SPAdes with the default setting (Siew et al., 2022; Wick et al., 2017).

The sequences obtained were uploaded to Metagenomic Rapid Annotations using Subsystems Technology (MG-RAST) (The Metagenomics RAST server; https://www.mg-rast.org) in fastq format with its metadata for annotation and analysis of the sequences (Meyer et al., 2008). The reads were taxonomically annotated by similarity searching against the RefSeq and KO database with default parameters. Percentage of taxonomy abundance was calculated based on the number of reads per taxa of interest over total number of reads obtained.

Results:

Quantification of Contaminants Isolated from the Lift Buttons

Out of the 46 lift buttons sampled, 28 cultured colonies were isolated, resulting in a prevalence of 30.4%. A total of 440 CFU/mL was isolated from the interior lift buttons (Table 1). Although floor 6 (PW) had the highest number of colonies, there was no difference in the mean across the different floors ($p>0.05$). Similarly, there was no significant difference observed in the means of lifts, floors and panel of interior lift buttons ($p>0.05$).

The exterior lift buttons exhibited a distinct outcome compared to the interior ones, with only 120 CFU/mL of bacteria isolated. Although lift button set 2 had more colonies than set 1, there was no difference in their mean counts. A comparison of the exterior lift button surfaces showed that floors 3 (OT & ICU) and 7 (GW) had higher colony counts than other floors, but the difference was not statistically significant.

Table 1: Quantification of bacteria on lift buttons across different floors in a public hospital (PH).

Lift details			Average colony forming unit per mL (CFU/mL ± SD)					
			Floor G	Floor 3	Floor 6	Floor 7	Floor 8	Total
Interior lift button	Lift A	Vertical panel	20 ± 28.3	0 ± 0.0	30 ± 42.4	0 ± 0.0	40 ± 28.3	110 ± 15.2
		Horizontal panel	20 ± 28.3	0 ± 0.0	0 ± 0.0	0 ± 0.0	0 ± 0.0	
	Lift B	Vertical panel	30 ± 14.1	20 ± 28.3	110 ± 99.0	10 ± 14.1	0 ± 0.0	240 ± 32.0
		Horizontal panel	10 ± 14.1	30 ± 42.4	0 ± 0.0	10 ± 14.1	20 ± 28.3	
	Lift C	Vertical panel	0 ± 0.0	0 ± 0.0	20 ± 28.3	0 ± 0.0	20 ± 28.3	90 ± 9.9
		Horizontal panel	0 ± 0.0	20 ± 28.3	10 ± 14.1	20 ± 28.3	0 ± 0.0	
Exterior lift button	Set 1	Up button	0 ± 0.0	0 ± 0.0	0 ± 0.0	0 ± 0.0	NA	50 ± 11.9
		Down button	NA	30 ± 42.4	0 ± 0.0	0 ± 0.0	20 ± 0.0	
	Set 2	Up button	10 ± 14.1	10 ± 14.1	0 ± 0.0	30 ± 42.4	NA	70 ± 9.9
		Down button	NA	0 ± 0.0	10 ± 14.1	10 ± 14.1	0 ± 0.0	
Total			90 ± 11.3	110 ± 12.9	180 ± 33.9	80 ± 10.3	100 ± 14.9	560 ± 18.7

NA = Data not available; SD = Standard deviation

Metagenomic Findings

Analysis of the metagenome showed that there were 2 628 047 number of reads, which approximates to a 1650 species count based on the rarefraction curve. The investigation of taxonomy abundance revealed bacteria as the highest contributor of species (Figure 2). The rank phylum illustrated Firmicutes as the amplest in the metagenome followed by Proteobacteria and Actinobacteria. The rank class was dominated by Bacilli with Clostridia as the second tier. Unclassified viruses and Saccharomycetes contributed less than 0.05% to the metagenome. The rank order was dominated by Bacillales, one of the order ranks for the class Bacilli. *Staphylococcaceae* and *Bacillaceae* were two of the highest prevalent distributors in the rank family while other families contributed only 1.15% to the metagenome. Deeper analysis of the genus rank showed that *Staphylococcus* contributed almost three-quarter of the species in the rank. *Bacillus* species came in second as the most found species in the metagenome followed by *Geobacillus, Anoxybacillus* and other species (Figure 3).

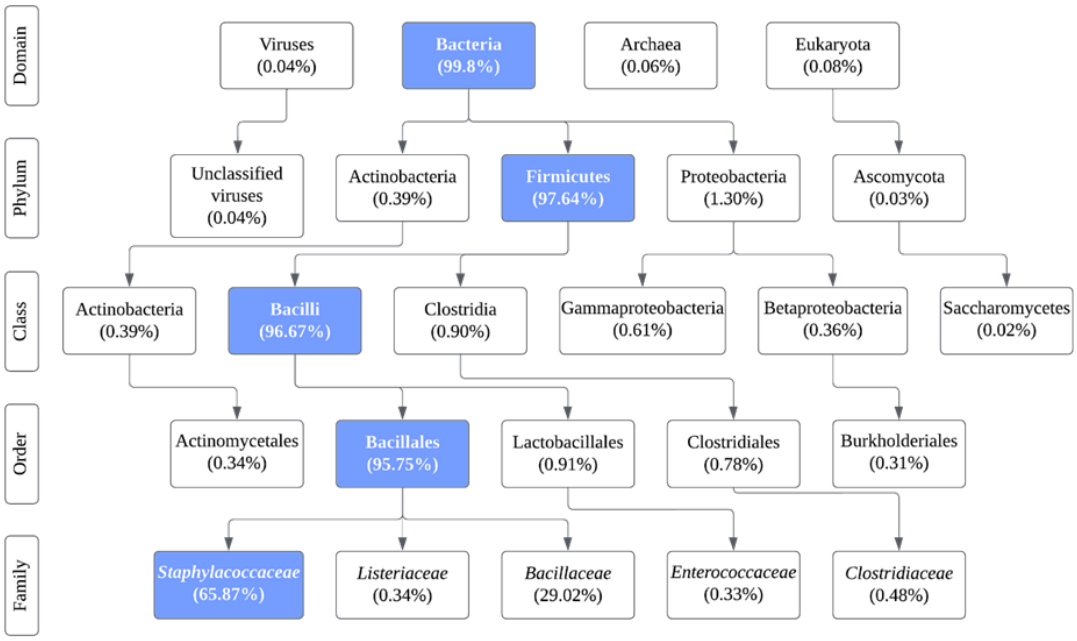

Figure 2: Taxonomy abundance at different hierarchy in PH metagenome. The blue box shows the highest abundance of species per rank. The figure includes only the top five or top six species in each rank. Species that reveal low taxonomy abundance are excluded.

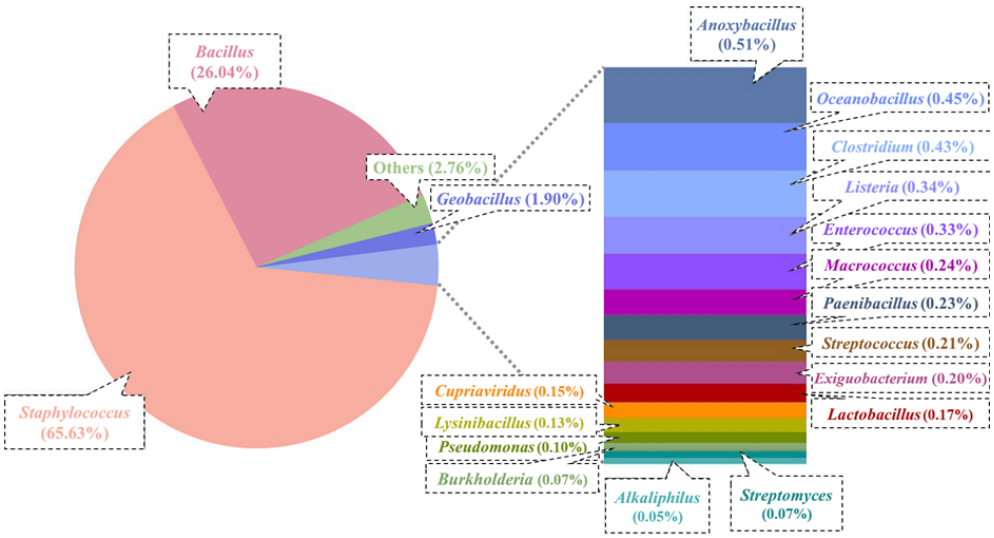

Figure 3: Taxonomic data of rank genus in PH metagenome. *Staphylococcus* and *Bacillus* made up around 90% of the species in rank genus. Other species listed total up to 5.58% with an average of 0.33% per species, excluding the segment labelled "others".

Table 2. Abundance of KEGG pathways in the hospital samples

Functional protein			Percentage of abundance (%)
Field	Group	Pathway	
EIP	Membrane transport	ABC transporters (PATH: ko02010)	7.9
GIP	Translation	Aminoacyl-tRNA biosynthesis (PATH: ko00970)	4.7
EIP	Signal transduction	Two-component system (PATH: ko02020)	4.4
Met	Amino acid metabolism	Alanine, aspartate and glutamate metabolism (PATH: ko00250)	3.8
Met	Amino acid metabolism	Glycine, serine and threonine metabolism (PATH: ko00260)	3.7
Met	Nucleotide metabolism	Purine metabolism (PATH: ko00230)	2.9
GIP	Translation	Ribosome (PATH: ko03010)	2.5
Met	Carbohydrate metabolism	Pyruvate metabolism (PATH: ko00620)	2.4
Met	Amino acid metabolism	Cysteine and methionine metabolism (PATH: ko00270)	2.3
GIP	Replication and repair	DNA replication (PATH: ko03030)	2.2
Met	Carbohydrate metabolism	Pentose phosphate pathway (PATH: ko00030)	2.2
Met	Amino acid metabolism	Arginine and proline metabolism (PATH: ko00330)	2.2
Met	Amino acid metabolism	Valine, leucine and isoleucine degradation (PATH: ko00280)	2.2
Met	Carbohydrate metabolism	Glycolysis / Gluconeogenesis (PATH: ko00010)	2.0
EIP	Membrane transport	Phosphotransferase system (PATH: ko02060)	2.0

EIP = Environmental Information Processing; GIP = Genetic Information Processing; Met = Metabolism; PATH = the pathway number annotated by the database. The table showed a part of the pathways analysed by the website. The total abundance of the pathway analysed by the website was 842, 746.

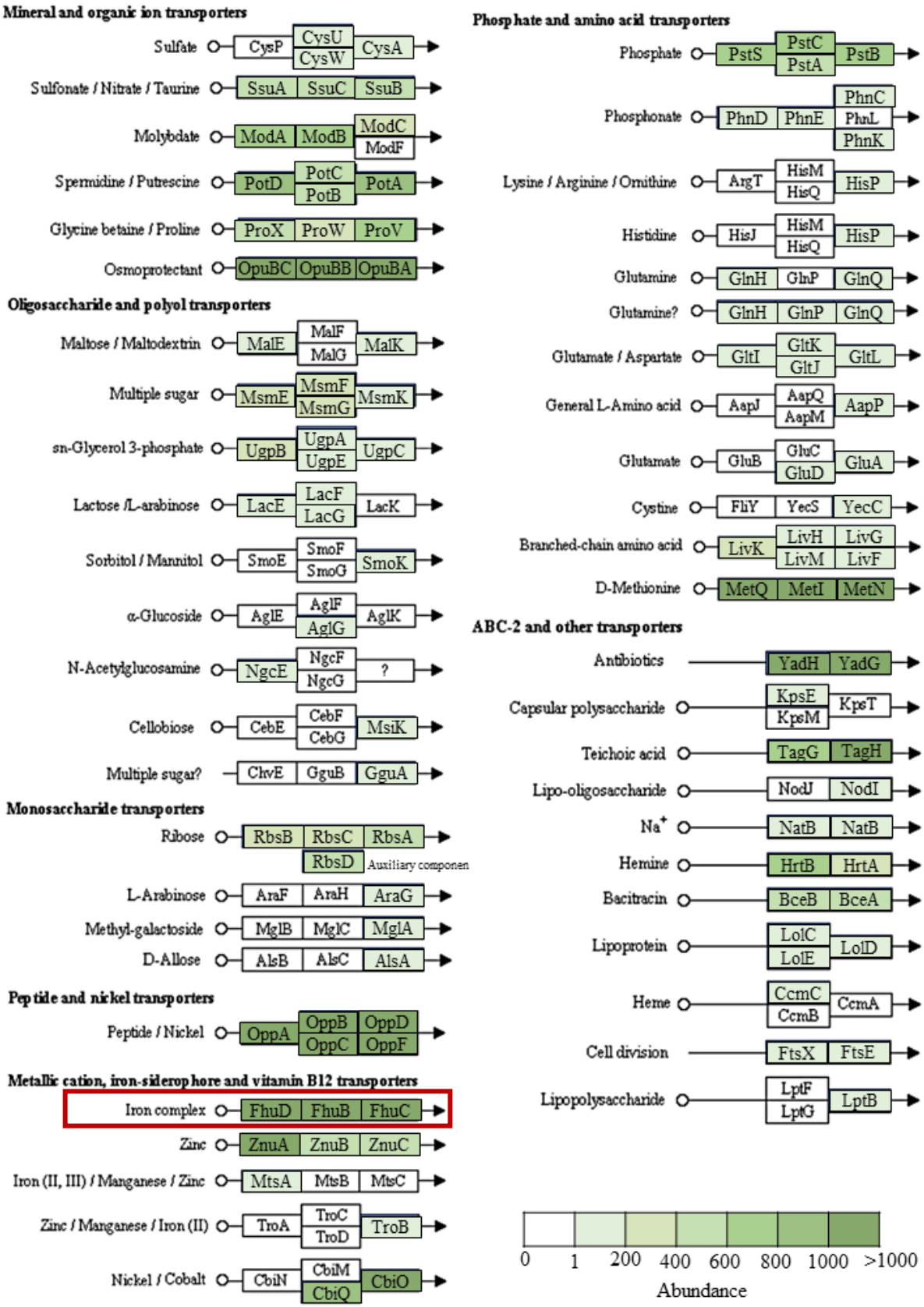

Figure 4: Genes enriched in the family of the ABC transporters pathways. The intensity of the colour green reflected the abundance of the enriched genes. The most enriched gene was *fhu*D (highlighted in red box), which expressed as substrate-binding protein in iron complex transport system.

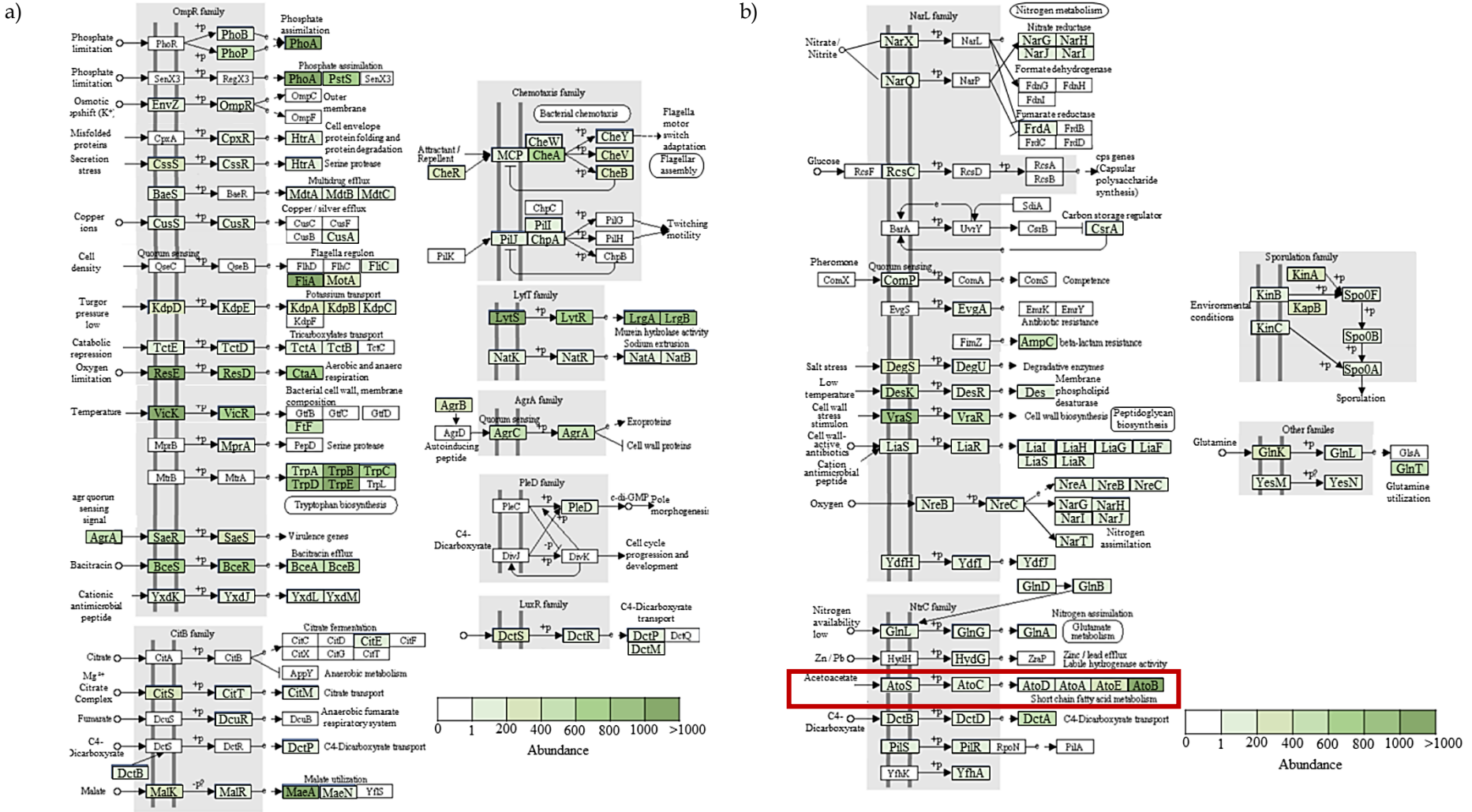

Figure 5: Pathways with enriched genes involving major family such as (a) OmpR and (b) NarL, under the two-component system. The intensity of the colour green reflected the abundance of the enriched genes. The most enriched gene in this system was *ato*B (highlighted in red box), which expressed as acetyl-CoA C-acetyltransferase. This protein plays a part in short chain acid metabolism under the NtrC family, a regulator that response to nitrogen level.

KEGG Pathway Analysis

A Kyoto Encyclopaedia of Genes and Genomes (KEGG) pathway was annotated using the plugins available from the analysis website. It should be noted that the analysis is not limited to a single organism and would involve all species in the metagenome. The pathway annotated by the website yielded fields and groups, as seen in Table 2. The system categorised the pathways into six different fields which were cellular processes, environmental information processing, genetic information processing, human diseases, metabolism and organismal systems. Most of the pathways shown were metabolic, while some of them were part of the genetic and environmental information processing fields. Other fields were less abundant and thus, were not highlighted in this study.

A total of 137 different pathways were created from 36 different groups or subsystems. The highest number of pathways expressed attributed to amino acid metabolism, totaling up to 22% of the whole annotated subsystem. The highest abundance of proteins was annotated from the ATP synthase binding cassette (ABC) transporters pathway, with notable differences from other pathways. This pathway along with the two-component system were investigated in greater depth since they play an important role in survivability of the species inhabiting the hospital lift buttons.

Each pathway consisted of several different gene sets which would be upregulated, downregulated or remained unchanged, depending on the internal and external stimulus received by the species. Figure 4 shows the enriched genes sets with different abundance grouped under the ABC transporters pathway. The abundance reflects the number of species with specific enriched genes. The most enriched genes in the pathway were *fhu*D and *fhu*B, proteins identified in the iron complex transport system. The hierarchy was followed by *opp*A (peptide/nickel transport system) and *fhu*C (iron complex transport system). Some of the genes enriched in the pathway, such as *yad*H, *yad*G, *bce*B and *bce*A, are involved in transporting antibiotics and other antimicrobial related matters from the cell.

The two-component system have 11 family categorised under it where OmpR and NarL family have a significant role in the antimicrobial resistant properties of the cell, as displayed in Figure 5. Several genes are enriched under the OmpR family including genes involved in multidrug efflux, virulence genes and bacitracin efflux. The gene enriched in the NarL family that have a similar effect on antimicrobial resistant properties is *amp*C, which promotes the resistance of the organism to beta-lactam antibiotics. The environment on lift buttons may also enrich the genes related to salinity, temperature, oxygen concentration and nutrient, which aids in prolonging the organisms survivability.

Discussion:

Prevalence Patterns of Contamination on Lift Buttons

The investigation on prevalence of contaminants on a public hospital's lift buttons yielded distinct outcomes compared to previous studies in other countries. It should be noted that there was an absence of pre-pandemic data on bacteria prevalence on lift buttons in the studied region, hindering a conclusive comparison over time. A study on two hospitals, located in Kenya and Nepal, reported a bacteria prevalence of 66.3-80.8% isolated from fomites in 2018, a pre-pandemic era (Bhatta et al., 2018; Maina et al., 2018). Later, other studies conducted revealed contaminants prevalence of approximately 50.0%, isolated from fomites in Egyptian and Chinese hospitals (El-Masry and Taha, 2022; Qin et al., 2022). This fluctuating trend between 2018 and 2022 suggest significant progress in addressing contaminants over time.

One important change during the pandemic was a more stringent cleaning routine, as mandated by the updated guidelines (MOH, 2021). The guidelines maintained similar equipment, chemicals and cleaning steps as before but with improved regularity. Daily cleaning routines utilized multipurpose detergent, while incident and decontamination routines employed broad-spectrum chlorine-based disinfectants. (Amir, personal communication, March 13, 2021). Cleaning frequency was determined by the lift's location, with low-risk areas needing weekly cleaning and moderate-risk areas requiring daily attention (Hashmi, 2014). However, there remained a lack of standardization in interpreting cleaned environmental surfaces in healthcare settings (CDC, 2015). Innovative approaches such as integrating ultra-violet light technology and voice-controlled systems in the lifts could supplement existing cleaning routines, offering touch-free alternatives and continuous disinfection to enhance infection control measures in healthcare settings.

Restrictions on visitor access during sample collection, coupled with the provision of hand sanitizer inside and outside lifts, were implemented in

hospitals during the pandemic to reduce contamination from human touch (Department of Educational Health, 2022). Additionally, environmental factors such as temperature and climate of the lifts also affect the colonisation and localisation of the bacteria. Some HAIs-causing agents, including *K. pneumonia* and *A. baumannii* exhibited higher incidence density in warmer weather while *S. aureus* and *E. faecium* thrive better in cold environments (Schwab et al., 2014). Hospital lifts typically maintain a constant comfortable temperature ranging from 15-32°C with adequate ventilation, creating an environment conducive to the proliferation of mesophilic bacteria (Parker et al., 2016)

The investigation into bacterial prevalence on lift buttons unveiled varied patterns across different floors housing diverse departments, challenging the notion that high-risk areas would consistently exhibit fewer contaminated lift buttons compared to moderate-risk areas Hashmi (2014). For instance, floors housing OT and PW showed higher bacteria prevalence compared to others. This was similarly seen in research conducted in a Nigerian hospital, where ICU exhibited significantly higher bacteria prevalence compared to PW (Olise and Simon-Oke, 2018). Even carbapenem-resistant *A. baumannii* was isolated from fomites in the ICUs, which showed sterility was compromised (Doughty et al., 2022). This deviation from expected sterility levels warrants further exploration into contamination dynamics within healthcare settings.

Microbial Diversity and its Survival Mechanisms

The metagenomic analysis of PH lift buttons unveiled diverse microbes with varying contamination levels. Utilizing genomic DNA for analysis provided insights into both viable and non-viable cells, encompassing a range of aerobic and anaerobic organisms. These contaminants could stem from various sources, including human contact and environmental factors, highlighting the potential pathways for contamination of lift buttons. Notably, previous research on fomite contamination, particularly lift buttons, is limited, and the application of metagenomic analysis in assessing microbial communities on hospital lift buttons is unprecedented, positioning this study as a pioneer in the field (Sukri et al., 2022).

Among the contaminants isolated from PH, included bacteria with several genera known for their association with HAIs. *Staphylococcus* was recognised as one of the most prevalent species in hospitals due to its association with human skin microflora (Ehlers and Merrill, 2022; Bhatta et al., 2018). Additionally, *Bacillus* known for its ability to form endospores, has exhibited resilience against disinfectants and environmental stressors (Ulrich et al., 2018). Actinomycetales, known for its antibiotic-producing capability, was also identified, posing potential risks for chronic, non-contagious infection due to trauma or surgery (Okulicz et al., 2022). Despite regular cleaning and disinfection routines, these species persist on lift buttons, suggesting the development of resistance to disinfectants over time.

The survival of contaminants on the lift buttons, even in low concentrations, hinges greatly on their survival mechanisms. Pathways such as ABC transport and two-component systems play crucial roles in normalizing and regulating responses to external and internal stimuli. Resistance to antimicrobial agents, such as bacitracin and cationic antimicrobial peptides, was observed among species in the metagenome. Bacitracin is an over-the-counter tropical antibiotic ointment and the resistance to it is documented in *B. subtilis* (Radeck et al., 2016). Cationic antimicrobial peptide, a natural antibiotic produced by living things, consist of short, hydrophobic molecules that harbour a net positive charge that act by cell membrane disruption, making it almost impossible to be resisted by the microbes (Zasloff, 2002). However, relative resistance to these peptides was observed in human gut microflora, suggesting the potential for resistance development in other microbial populations (Ge et al. 1999).

Conclusion:

In conclusion, the investigation into the contaminant's prevalence on lift buttons in this public hospital revealed intriguing findings that enlighten the microbial colonisation and their survival mechanisms in a hospital environment. A notable prevalence of contaminants was observed despite regular cleaning routines, with 30.4% of interior lift buttons and 120 CFU/mL of bacteria isolated from the exterior lift buttons. Remarkably, there was no substantial difference in contaminant prevalence observed between lifts situated in high-risk and moderate-risk areas, highlighting uniform contamination level across the sampled areas. Metagenomic analysis provided valuable insights into the microbial diversity on lift buttons, with Firmicutes identified as the dominant phylum. The genus-level analysis revealed *Staphylococcus* and *Bacillus* as the most prevalent species, underscoring their persistence despite cleaning efforts. Furthermore, the annotation of KEGG pathways shed light on the metabolic

pathways and survival mechanisms employed by these microbial communities. A closer examination of the ABC transporters pathway highlighted the role of genes involved in iron complex transport and antimicrobial resistance, suggesting adaptive responses to environmental pressures. Similarly, the two-component system revealed enrichment of genes associated with multidrug efflux and antimicrobial resistance, indicative of the microbial community's ability to adapt to external stimuli. However, it is important to acknowledge that the study only focused on one hospital in a specific region, limiting the diversity captured across various healthcare facilities. Additionally, the absence of pre-pandemic data on contaminant prevalence and a detailed exploration of cleaning schedules in prior research limits the study's capacity to make comprehensive comparisons. Overall, these findings underscore the complex interplay between environmental factors, microbial colonization, and survival strategies of microbial contaminants on lift buttons in hospital settings. Understanding these dynamics is crucial for implementing effective infection control measures and mitigating the risk of HAIs. Future studies could broaden the geographical scope to encompass diverse hospital settings and to conduct in-depth analyses of cleaning routines, which would provide valuable insights for optimizing hygiene practices on frequently touched surfaces like lift buttons. Likewise, further research into the functional capabilities of these microbial communities and their interactions with the hospital environment is warranted to inform targeted interventions and improve patient safety.

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