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دور التثقيف الصحي المدرسي في تحسين معرفة ومواقف وسلوك الطلاب تجاه المخدرات بين طلبة المرحلة الثانية من التعليم الأساسي بمدينة سبها- ليبيا، دراسة تدخلية

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** ماجستير في الصحة العامة (التثقيف الصحي) جامعة العلوم والتكنولوجيا باربد بالاردن, دكتوراه في الصحة العامة جامعة شندي

المستخلص

إجريت هذا الدراسة التدخليه الميدانيه مستخدماً المنهج شبه التجريبي، تكونت العينة من ٣٨٢ طالب وطالبة تم اختيارهم بطريقة عدلية من المجتمع الكلي البالغ عدده (٩١٥٠) طالباً، وهدفت هذه الدراسة إلى تطبيق برنامج إرشادي لمكافحة تعاطي المخدرات، وقد جمعت البيانات باستخدام استمارتي استبيان (قبلي وبعدي) لمعرفة مدى تغيير اتجاهات المبحوثين، أجريت بالمدارس التي تم اختيارها وعددها (٣٦ مدرسة حكومية وخاصة) ومن أهم النتائج التي توصلت إليها الدراسة: (حدوث تغير في اتجاهات عينة البحث على مستوى الوقاية من تعاطي المخدرات، ويرجع ذلك إلى تفاعل الطلاب مع البرنامج والإرشادات والتوجيهات المستخدمة سواء الحوار، النقاش أو التداعي الحر، وهو ما أثر بالإيجاب على نتائج البرنامج، نجد أن الدرجة الكلية لإجابات أفراد العينة على المقياس ارتفعت بصورة واضحة؛ حيث كان الوزن النسبي للمقياس قبل تطبيق البرنامج (٧٧,٨%) بينما بعد تطبيق البرنامج ارتفع إلى (٩٥%)، وهو ما دل على نجاح البرنامج الإرشادي وبفعالية في تغيير اتجاهات المبحوثين نحو المخدرات لصالح التطبيق البعدي، كذلك توصلت الدراسة إلى أنه (توجد فروق دالة إحصائياً في اتجاهات عينة البحث نحو المخدرات قبل تطبيق البرنامج وبعده)، و(توجد فروق دالة في اتجاهات المبحوثين نحو المخدرات للتطبيق القبلي للبرنامج الإرشادي تعزى لوجود متعاطي بالأسرة، بينما لا توجد فروق دالة إحصائياً للتطبيق البعدي)، و(توجد فروق دالة في اتجاهات المبحوثين نحو المخدرات للتطبيق القبلي للبرنامج الإرشادي تعزى لدخل الأسرة، بينما لا توجد فروق دالة للتطبيق البعدي)، و(توجد فروق دالة في

اتجاهات المبحوثين نحو المخدرات للتطبيق القبلي للبرنامج الإرشادي تعزى للمستوى التعليمي للأب، بينما لا توجد فروق دالة للتطبيق البعدي)، وواصت الدراسة: ضرورة إقامة برامج تثقيفية متنوعة بالمدارس تجدد التثقيف بأضرار المخدرات وكيفية الوقاية منها، أضافة إلى تفعيل الشراكة بين الأسرة والمدرسة فيما يخص تربية الأبناء عن طريق مجلس الآباء والمعلمين.

الكلمات الدليلية: التثقيف الصحي, المعرفة, المواقف, السلوك, الطلاب, المخدرات

Abstract

Intervention study has been conducted, Using the quasi-experimental approach through a health counseling program to combat drug abuse, the sample consisted of 382 students who were randomly selected from the total community of (9150) students, and the aim of this research was to implement a counseling program to combat drug abuse. Data were collected using two questionnaires (before and after) to find out the extent of changing the attitudes of the respondents, and the extension program included a system of sessions (eight sessions) over a range (About three months), it was conducted in (36 public and private schools) that were selected and among the most important findings of the research: At the level of drug abuse prevention, and this is due to the interaction of the students with the program and the instructions and directions used, whether dialogue, discussion or free association, which positively affected the results of the program, and we find that the total score of the responses of the sample members on the scale increased clearly; Whereas, the relative weight of the scale before implementing the program was (77.8%), while after the implementation of the program it increased to (95%), which indicated the success of the counseling program and effectively in changing the attitudes of the respondents towards drugs in favor of the post application. The study also found that (there are significant differences Statistically in the trends of the study sample towards drugs before and after the implementation of the program), and (there are significant differences in the trends of the respondents towards drugs for the pre-application of the indicative program due to the presence of family abusers, while there are no statistically significant differences for the post application), and (there are significant differences in the trends of the respondents Towards drugs for the pre-application of the counseling program due to the family income, while there are no significant differences for the post application), and (there are significant differences in the attitudes of the respondents towards drugs for the pre-application of the counseling program due to the educational level of the father, while there are no significant differences for the post application). The study recommended that: The necessity of establishing various refresher programs in schools that renew education about the harms of drugs and how to prevent them, targeting teachers and parents of both sexes with counseling programs on the dangers of drugs and how to protect children from them.

المقدمة

تعد مشكلة المخدرات من أخطر وأعقد المشكلات الاجتماعية التي تهدد كل المجتمعات في العصر الحديث المتقدمة منها والنامية على حد سواء، وترجع خطورة هذه المشكلة لكونها تستهدف أهم فئة في المجتمع ألا وهي فئة الشباب، من سيعتمد عليهم كصانعين للتقدم، وعصب التنمية بالنسبة للدول، ونظراً لخطورة ظاهرة تعاطي المخدرات فقد حظيت باهتمام كافة الدول من خلال المنظمات والهيئات المحلية والدولية، لإيجاد سبل التصدي لهذه الظاهرة الخطيرة.[١]

والمخدرات معروفة منذ القدم، وقد كانت تستخدم لتخفيف الآلام، ثم تطور الأمر فأصبحت تستخدم لتغييب العقل، ناهيك عن الآثار السلبية التي تخلفها (صحية، اجتماعية، اقتصادية، بيئية، وغيرها)، والإدمان عليها "يحدث في أي سن ولكن أغلب ما يكون في سن المراهقة وأوائل مرحلة الرشد، وهذا يرجع إلى أن الشباب أكثر ميلاً في هذه المرحلة إلى المخاطرة والمغامرة، وإلى حب اكتشاف الجديد".[٢] والتعريف العلمي لها هي أي مادة كيماوية تؤدي إلى الخدر والنوم, وفقدان الوعي،[٣]

يصل حجم الإتجار العالمي بالمخدرات إلى حوالي (٧٠٠) مليار دولار،وإن حوالي (٤%) من سكان العالم يتعاطون المخدرات، أي قرابة (١٨٥) مليون شخص يتعاطون المخدرات في العالم، (١٣) مليون يتعاطون مخدر الكوكايين، و(١٥) مليون يتعاطون الأفيون ومشتقاته، و(١٥٠) مليون يتعاطون مخدر الحشيش، و(٧) مليون يتعاطون مواد نفسية، وتشير تقديرات منظمة الصحة العالمية إلى وفاة (٢٠٠,٠٠٠) مائتي ألف شخص بسبب تعاطي المخدرات عام ٢٠٠٠، وهو ما يعادل (٠,٤%) من نسبة الوفيات في العالم.[٣]

ولم تكن مشكلة المخدرات في ليبيا واضحة المعالم حتى تم افتتاح قسم علاج المدمنين بمستشفى الأمراض النفسية بطرابلس المعروف بقسم (زياد) لعلاج الإدمان، وكان ذلك في بداية عام ١٩٩٢، وكان الاعتقاد السائد لدى اللجنة المكلفة بإدارة القسم أن الحالات التي ستتقدم للعلاج ستكون حالات تعاطي الخمور، أو مخدر الحشيش، ولكن تفاجأ الجميع بأن ٩٠% من الحالات المتقدمة للعلاج طواعية كانت ترغب في العلاج من إدمان مخدر الهيروين.[٣]

أما مشكلة المخدرات في مدينة سبها فتكمن في انتشارها وبشكل متزايد، وذلك من خلال الإحصائيات والأرقام التي تم الحصول عليها من مكتب المكافحة ببلدية سبها، من خلال الحالات التي تم ضبطها حيث تفيد أنه في عام ١٩٩٩ بلغ عدد المتعاطين للمخدرات (٢٠) متعاطياً، ثم ارتفع العدد عام ٢٠٠١ إلى (٣٥) متعاطياً، وفي عام ٢٠٠٢ ارتفع عدد المتعاطين ووصل إلى (٨٨) متعاطياً، وقد يرجع ذلك إلى وجود العديد من الأسباب والعوامل الدافعة لتعاطي وتجارة المخدرات بين الشباب داخل المجتمع الليبي ومن أهمها (الفراغ، رفاق السوء، توافر المخدرات داخل المجتمع، رخص المخدرات، طغيان الجانب المادي على النواحي الروحية بالمجتمع، ضعف الرقابة على الحدود والمنافذ، الجهل بالمخدرات وآثارها، حب التجربة والمحاكاة، البحث عن الإثارة والمتعة الحسية، الأفكار والمعتقدات الخاطئة عن المخدرات، عدم تنفيذ التشريعات الخاصة بتجارة المخدرات، توفر المال لدى البعض، سوء التربية والتنشئة الاجتماعية، وجود القدوة السيئة بالبيت، الثقافات الدخيلة والشاذة، تدهور القيم والمثل داخل المجتمع، الفشل والإحباط المتكرر، ضعف الرقابة على الأبناء،

الأمراض النفسية) هذه الأسباب وغيرها جعلت من مشكلة المخدرات بين الشباب في تزايد مستمر بناءً على المؤشرات المرصودة خلال عام ٢٠١٩,[٤]

تعتبر المدرسة مؤسسة تعليمية وتربوية تلعب دوراً هاماً في تكوين الطلاب من الناحية التعليمية والثقافية، كما أنها ترعى الطلاب من الناحية الصحية وتعمل على إكسابهم المعرفة والمواقف والسلوك الصحي السليم.[٥] وقد تناول هذا الدراسة (دور التثقيف الصحي المدرسي في تحسين معرفة ومواقف وسلوك الطلاب تجاه تعاطي المخدرات بين طلاب مرحلة التعليم الإعدادي بمدينة سبها– ليبيا– في لفترة من٢٠١٨ – ٢٠١٩), بهدف المساهمة في الحد أوالتقليل منها، أو محاولة القضاء على ممارسة هذه العادة لما يتبعها من أضرار.

إجراءات الدراسة المنهجية

أولاً: نوع الدراسة والفترة الزمنية:

هذه دراسة ميدانيه (تدخليه) إرشاديه صحيه تثقيفيه اجريت بهدف مكافحة مشكلة تعاطي المخدرات أو التقليل منها بين طلبة المرحلة الثانية من التعليم الأساسي قي الفترة (٢٠١٩ – ٢٠١٨).

ثانياً: مجتمع الدراسة:

يتكون المجتمع الأساسي للدراسة من طلاب المرحلة الثانية من التعليم الأساسي (المرحلة الإعدادية) من الفئة العمرية ١٣– ١٥ سنة والبالغ عددهم (٩١٥٠) طالب من كلا الجنسين، منهم عدد (٤٣٩٩) ذكور، و(٤٧٥١) إناث.

ثالثاً: حجم العينة:

تم استخدام طريقة (هربرت اركن) لتحديد حجم العينة وفق المعادلة التالية:

$$n = \frac{P\,(1-P)}{(SE \div t) + p\,(1-p) \div N}$$

=nحجم العينة

P = 50% =نسبة توفر الخاصية و المحايده

SE = 0.05 =نسبة الخطا

T = 1.96القيمة المعيارية بمعدل الثقة ٩٥% =

N =حجم مجتمع الدراسة = ٩١٥٠

بعد استخدام طريقة هربرت اركن خلصت النتيجة النهائية إلى أن (حجم) عدد مفردات العينة التي سيتم تحليلها هي (٣٨٢) طالب من المجموع الكلي للطلبة والبالغ عددهم (٩١٥٠) طالب من كلا الجنسين.

رابعاً: طريقة سحب العينة:

تم اختيار العينة عن طريق أسلوب العينات الاحتمالية (العينة العدلية المنتظمة) بنسبة ٤,١٧% من مجتمع البحث موزعين حسب عدد الطلاب لكل مدرسة من المدارس.

خامساً: أدوات الدراسة:

الاستبيان:

تم جمع المعلومات بطريقة الاستبيان المغلق استخدم قبل وبعد عملية التدخل بالبرنامج الإرشادي الصحي التثقيفي.

البرنامج الإرشادي الصحي:

يتمثل الإرشاد الصحي في هذه الدراسة في محاضرات علمية توعوية تثقيفية، قام بها الباحث، بالإضافة إلى إرشادات دينية داخل المدارس المستهدفة، وأيضاً برامج أخرى مصاحبة تثقيفية عبر وسائل الإعلام المحلية المسموعة والمرئية والمقروءة، بالإضافة إلى عدد من المطبوعات اشتملت على ملصقات ومطويات ولوحات إرشادية، وكذلك مسابقات قدمت خلالها جوائز ذات طابع معنوي كحوافز لجميع المشاركين.

سادساً: الأساليب الإحصائية المعتمدة في تحليل النتائج:

قام الباحث باستخدام برنامج الحزم الإحصائية للعلوم الاجتماعية, الإصدار١٦, لتحليل النتائج ومن ثم عرض البيانات بشكل مختصر ومفيد، في شكل جداول وأشكال بيانية.

SPSS (Statistic Package for Social Science)

سابعاً: الاعتبارات الأخلاقية:

- تمت موافقة إدارة الخدمات الصحية و إدارة قطاع التعليم وقسم الصحة المدرسية ومكتب الاوقاف وشؤون الزكاة ووسائل الاعلام وجمعية الهلال الاحمر سبها وذلك بشأن التعاون بالخصوص.

النتائج والمناقشة

جدول (١) المتوسطات الحسابية والانحراف المعياري والوزن النسبي لأبعاد المقياس قبل التطبيق:

الأبعاد	الوزن النسبي	الترتيب
أسباب التعاطي	%79.4	٣
أضرار التعاطي	%81.1	٢
فوائد التعاطي	%67.3	٤
علاج التعاطي	%82.8	١
الدرجة الكلية	%77.8	

من خلال الجدول المبين أعلاه، يتضح أن البعد الرابع للمقياس "علاج التعاطي"، قبل تطبيق البرنامج نال المرتبة الأولى حيث بلغ وزنه النسبي (٨٢,٨)%، وهو أعلى الأوزان النسبية، ثم يليه البعد الثاني ووزنه النسبي (٨١,١)%، ثم يليه البعد الأول ووزنه النسبي (٧٩,٤)%، ثم البعد الثالث ووزنه النسبي (٦٧,٣)%، كما نجد أن الوزن النسبي للدرجة الكلية بلغ (٧٧,٨)%.

جدول (٢) المتوسطات الحسابية والانحراف المعياري والوزن النسبي لأبعاد المقياس بعد التطبيق:

الأبعاد	الوزن النسبي	الترتيب
أسباب التعاطي	%98.4	1
أضرار التعاطي	%92.8	4
فوائد التعاطي	%95.3	2
علاج التعاطي	%93.5	3
الدرجة الكلية	%95	

من خلال الجدول المبين أعلاه، يتضح أن البعد الأول للمقياس "أسباب التعاطي" بعد تطبيق البرنامج حاز المرتبة الأولى حيث بلغ وزنه (٩٨,٤)%، وهو أعلى الأوزان النسبية، ثم يليه البعد الثالث " فوائد التعاطي" ووزنه النسبي (٩٥,٣)%، ثم يليه البعد الرابع "علاج التعاطي" ووزنه النسبي (٩٣,٥)%، يليه البعد الثاني "أضرار التعاطي" ووزنه النسبي (٩٢,٨)%،ويلاحظ أن الوزن النسبي للدرجة الكلية (٩٥)%،وتشير النتائج السابقة إلى التقدم الذي حدث لدى عينة الدراسة على مستوى الوقاية من تعاطي المخدرات، ويرجع ذلك إلى تفاعل التلاميذ في البرنامج مع الإرشادات والتوجيهات المستخدمة سواء الحوار والنقاش أو التداعي الحر، وهو ما أثر بالإيجاب على نتائج البرنامج، ونجد أن الدرجة الكلية لإجابات أفراد العينة على المقياس ارتفعت بصورة واضحة حيث كان الوزن النسبي للمقياس قبل تطبيق البرنامج (٧٧,٨)% بينما بعد تطبيق البرنامج ارتفع إلى (٩٥)%.

جدول (٣) يوضح نتائج اختبار (ت) للفرق بين متوسطي مجموعتين مرتبطتين لمعرفة دلالة الفروق في اتجاهات عينة البحث نحو المخدرات قبل تطبيق البرنامج وبعده. (ن=٣٨٢)

الأبعاد (قبل- بعد)	(ت)	درجات	قيمة احتمالية	الاستنتاج
أسباب التعاطي	-18.811	381	٠.000	دال إحصائياً
أضرار التعاطي	-15.285	381	٠.000	دال إحصائياً
فوائد التعاطي	-24.778	381	٠.000	دال إحصائياً
علاج التعاطي	-17.216	381	٠.000	دال إحصائياً
الدرجة الكلية	-26.974	381	٠.000	دال إحصائياً

من خلال الجدول المبين أعلاه، يتضح أن قيمة (ت) المحسوبة لجميع الأبعاد وللدرجة الكلية ذات دلالة إحصائية عند مستوى أقل من (٠,٠٥)، مما يعني وجود فروق بين متوسطات درجات هذه الأبعاد، وبما أن متوسط الفرق سالب، هذا يعني أن متوسطات درجات الأبعاد بعد تطبيق البرنامج أكبر من المتوسطات قبل تطبيق البرنامج، هذه النتيجة تؤكد تحقق الفرض الذي وضعه الباحث أي أنه توجد فروق ذات دلالة إحصائية في اتجاهات عينة البحث نحو المخدرات قبل تطبيق البرنامج وبعده.

إن هذه النتيجة تتفق مع ما توصلت إليه نتائج دراسة، [٧] والتي أشارت إلى أنه: توجد فروق ذات دلالة إحصائية بين متوسطات درجات طلاب المرحلة الثانوية المعرضين لخطر التعاطي قبل وبعد تطبيق البرنامج الإرشادي وذلك لصالح

القياس البعدي، وأيضاً اتفقت مع ما توصلت إليه نتائج دراسة، [٨] والتي أشارت إلى تغيير اتجاهات وممارسات عينة الدراسة نحو المخدرات للأفضل بعد البرنامج الإرشادي، وكشفت النتائج بعد المتابعة، عن استمرارية فاعلية البرنامج الإرشادي الوقائي الذي يشير إلى الآثار الإيجابية بعيدة المدى للبرنامج، إتفاق أخر للنتيجة في تحقيق الفرض الذي وضعه الباحث كان مع ما توصلت إليه نتائج دراسة، [٩] والتي خلصت إلى أنه توجد فروق بين التطبيق القبلي والتطبيق البعدي لمقياس اسلوب حل المشكلات، ومقياس التوجه نحو التعافي من الإدمان على الترامادول لدى أفراد المجموعة التجريبية لصالح التطبيق البعدي، الذي أشار إلى بقاء أثر إيجابي للبرنامج، فعلى ذلك، يتضح لنا بأن نتائج الدراسات أثبتت نجاح تلك البرامج في مكافحة المخدرات بين شريحة مهمة من شرائح المجتمع ألا وهي فئة الطلاب، حيث أن أهم التدابير الوقائية المقترحة لحمايتهم من خطر التعاطي، هي ضرورة القيام ببرامج التوعية والإرشاد بمخاطر التعاطي لجهلها من قبل الكثير منهم، لأن قلة المعرفة بالمخدرات تقود للتعاطي من قبل المعرضين لها، وقد ثبتت فعالية تلك البرامج، وظهر ذلك جلياً خلال نتائج دراسة، [٥] والتي توصلت إلى إثبات فعالية أهمية التوعية والتثقيف بأضرار المخدرات في تنمية المعلومات وتغيير الاتجاهات لدى المبحوثين، وذلك بنفس الأسلوب المعتمد بدراستنا هذه، وهو من خلال زيادة الوعي بأسباب وأضرار هذه الظاهرة وكيفية التعامل معها والحد منها، وغرس الاتجاهات السليمة نحو خطر المخدرات وأضرارها لدى الشباب بواسطة التوعية والتعليم والتدريب.

جدول رقم (٤) يوضح نتائج اختبار (ت) للفرق بين متوسطي مجموعتين مستقلتين لمعرفة دلالة الفروق في اتجاهات المبحوثين نحو المخدرات بعد تطبيق البرنامج تعزى لوجود متعاطي بالأسرة (نعم / لا). (ن=٣٨٢)

الأبعاد	التعاطي	(ت) محسوبة	درجات	قيمة	الاستنتاج
أسباب التعاطي	نعم	-0.٤٢٧	٣٨٠	٠,٦٧٠	غير دال
	لا				
أضرار التعاطي	نعم	٠,١٦١	٣٨٠	٠,٨٧٢	غير دال
	لا				
فوائد التعاطي	نعم	١,٤٢٦	٣٨٠	٠,١٥٥	غير دال
	لا				
علاج التعاطي	نعم	١,٣١٤	٣٨٠	٠,١٩٠	غير دال
	لا				
الدرجة الكلية	نعم	١,٠٢٩	٣٨٠	٠,٣٠٤	غير دال
	لا				

من خلال الجدول المبين أعلاه، يتضح أن قيمة (ت) المحسوبة لجميع الأبعاد وللدرجة الكلية غير دالة إحصائياً عند مستوى (٠,٠٥)، مما يعني عدم وجود فروق بين متوسطات درجات هذه الأبعاد بين الذين يوجد بأسرهم أفراد يتعاطون المخدرات أو لا يتعاطونها في اتجاهاتهم نحو المخدرات بعد تطبيق البرنامج.وهذه النتيجة تشير إلى تحقق جزئي للفرض الذي تم وضعه، أي أنه توجد فروق دالة إحصائياً عند مستوى (٠,٠٥) في اتجاهات المبحوثين نحو المخدرات للتطبيق القبلي للبرنامج الإرشادي تعزى لوجود متعاطي بالأسرة (نعم / لا)، بينما لا توجد فروق دالة إحصائياً للتطبيق البعدي.

وهنا يمكن القول بأن البرنامج الإرشادي قد نجح في تغيير اتجاهات المبحوثين نحو المخدرات بعد أن كانت أفكارهم مشتتة وغير منظمة حول ظاهرة تعاطي المخدرات، وقد أدى تنفيذ هذا البرنامج إلى تغيير اتجاهات المبحوثين وتنظيمها.

وهذه النتيجة اتفقت مع ما توصلت إليه نتائج دراسة، [١٠] والتي أشارت إلى أن المشكلات الأسرية المتمثلة في وجود متعاطي بالأسرة تعتبر من أهم أسباب الوقوع في الإدمان خاصة إذا كان ذلك من قبل أحد الوالدين، فإن تقليد سلوك الوالدين ومحاكاتهم في تصرفاتهم أقرب عند الأبناء من غيرهم.

كما أنها تختلف مع ما توصلت إليه نتائج دراسة، [١١] والتي أشارت إلى أنمعظم المبحوثين يرى أن وجود أحد أفراد الأسرة يتعاطى المخدرات لا يؤثر في الانجرار للتعاطي. فالملاحظ بهذا البحث أن أفراد العينة في الاستبيان القبلياتفقوا على أن وجود شخص متعاطي بالأسرة يمكن أن يؤثر بالعائلةبواسطةالاقتداء، إلا أن هذا الرأي تغير في نتائج الاستبيان البعدي نتيجة التعرف أكثر على المعلومات الخاصة بالمخدرات أثناء التدخل، الأمر الذي على ما يبدو أنه جعلهم يقتنعون بخطورة تعاطي المخدرات والتي يجب الابتعاد عن أسباب تعلم تعاطيها حتى وإن كان ذلك السبب هو وجود أحد أفراد الاسرة يتعاطاها، بالرغم من أن السائد منطقياً أن كلاً من الآباء والامهات يعتبرون القدوة الأساسية لأبنائهمحتى لو لم يقوموا بنفس الأفعال، فالاقتداءيمكن أن يكونأهم أسباب تعاطي المخدرات واكتساب سلوكيات حسنة أو سيئة عن طريق الوالدين أو الأخوة في أحيان كثيرة.

جدول رقم (٥) يوضح نتائج اختبار (ت) للفرق بين متوسطي مجموعتين مستقلتين لمعرفة دلالة الفروق في اتجاهات المبحوثين نحو المخدرات بعد تطبيق البرنامج تعزى لوجود رفاق السوء(نعم / لا). (ن=٣٨٢)

الأبعاد	رفاق	(ت)	درجات	قيمة	الاستنتاج
أسباب التعاطي	نعم	١,٤٩٣	٣٨٠	0.١٣٦	غير دال
	لا				
أضرار التعاطي	نعم	١,١٤٠	٣٨٠	0.٢٥٥	غير دال
	لا				
فوائد التعاطي	نعم	-0.٨٦٩	٣٨٠	0.٣٨٥	غير دال
	لا				
علاج التعاطي	نعم	١,٨٢٢	٣٨٠	0.٠٦٩	غير دال
	لا				
الدرجة الكلية	نعم	0.٤٤٩	٣٨٠	0.٦٥٤	غير دال
	لا				

من خلال الجدول السابق، يتضح أن قيمة (ت) المحسوبة لجميع الأبعاد وللدرجة الكلية غير دالة إحصائياً عند مستوى (٠,٠٥)، مما يعني عدم وجود فروق بين متوسطات درجات هذه الأبعاد حول وجود رفقاء السوءواتجاهاتهم نحو المخدرات بعد تطبيق البرنامج.

وهذه النتيجة تشير إلى عدم تحقق الفرض الذي تم وضعه، أي أنه لا توجد فروق دالة إحصائياً عند مستوى (٠,٠٥) في اتجاهات المبحوثين نحو المخدرات للتطبيق القبلي والبعدي للبرنامج الإرشادي تعزى لوجود رفاق السوء (نعم/ لا).

وهذا يعني أن اتجاهات المبحوثين نحو رفقاء السوء لم تتغير مع تنفيذ البرنامج الإرشادي، مع العلم أن تأثير هؤلاء من الثوابت الثقافية، إذ لا يختلف إثنان على التأثير السالب للرفاق السيئين.

وهذه النتيجة تختلف مع ما توصلت إليه نتائج دراسة كلاً من، [١٤] و، [١٥] و، [١٦] والتي أشارت إلى أن أهم الأسباب التي تؤدي إلى تعاطي المخدرات كانت تتمثل في تأثير رفقاء السوء، وفي هذا البحث أفاد المبحوثين خلال الاستبيان القبلي بعدم تأثير رفاق السوء في تعلم التعاطي وذلك لجزمهم أن هذا الفعل سيئ لعدم قبوله من الأهل والمجتمع سواء تم تعلمه من قبل الأصدقاء أو غيرهم، وقد قاموا بالتأكيد على ذلك بالاستبيان البعدي والذي أظهر وأكد لهم أن من أهم الأسباب المؤدية إلى الإدمان هو تأثير رفقاء السوء، سواء بالترغيب، أوالحث، أوالتوريط، أوالتقليد، فجماعة الرفاق بيئة اجتماعية صغيرة تؤثر بشكل مباشر على شخصية كل فرد، فالتفاعل مع الأقران والرفاق يؤدي إلى إنتقال الأفكار، وتعلم السلوكيات سواء كانت إيجابية أوسلبية.

_جدول رقم (٦) يوضح نتائج اختبار تحليل التباين الأحادي للفرق بين متوسطات المجموعات لمعرفة دلالة الفروق في اتجاهات المبحوثين نحو المخدرات بعد تطبيق البرنامج تعزى لمتغير الوضع الاقتصادي للأسرة "دخل الأسرة" (أقل من ٥٠٠ د.ل منخفض/من ٥٠١ – ١٥٠٠ د.ل متوسط/من ١٥٠١ فأكثر عالي). (ن=٣٨٢)

الأبعاد	مصدر التباين	مجموع	درجة	(ف)	قيمة	الاستنتاج
أسباب التعاطي	بين مجموعات	0.303	2	2.757	0.065	غير دال
	داخل مجموعات	20.790	379			
	الكلي	21.092	381			
أضرار التعاطي	بين مجموعات	0.014	2	0.480	0.619	غير دال
	داخل مجموعات	5.446	379			
	الكلي	5.459	381			
فوائد التعاطي	بين مجموعات	0.138	2	0.332	0.718	غير دال
	داخل مجموعات	78.558	379			
	الكلي	78.695	381			
علاج التعاطي	بين مجموعات	0.078	2	2.528	0.081	غير دال
	داخل مجموعات	5.847	379			
	الكلي	5.925	381			
الدرجة الكلية	بين مجموعات	0.081	2	1.291	0.276	غير دال
	داخل مجموعات	11.880	379			
	الكلي	11.961	381			

من خلال الجدول المبين أعلاه، يتضح أن قيمة (ف) المحسوبة لجميع الأبعاد والدرجة الكلية ليست ذات دلالة إحصائية عند مستوى (٠,٠٥) مما يعني عدم وجود فروق بين متوسطات هذه الأبعاد تعزى لدخل الأسرة بعد تطبيق البرنامج.

وهذه النتيجة تشير إلى تحقق جزئي للفرض الذي تم وضعه أي أنه توجد فروق دالة إحصائياً عند مستوى (٠,٠٥) في اتجاهات المبحوثين نحو المخدرات للتطبيق القبلي للبرنامج الإرشادي تعزى لدخل الأسرة، بينما لا توجد فروق دالة إحصائياً للتطبيق البعدي.

هذه النتيجة تتفق مع ما توصلت إليه نتائج دراسة، [١٧] والتي أشارت إلى أن الفقر المادي للأسرة والبطالةعوامل مساعدة في ظهور حالات التعاطي في المجتمع، وتختلف مع ما توصلت إليه نتائج دراسة، [١٨] والتي أشارت إلى أن المستوى الاقتصادي له دور فعال في عملية الاتجاه نحو الإدمان، خاصة إذا ما توفر المال دون رقابة من الآباء للأبناء.

كما أن قلة الدخل الإقتصادي للأسرة غالباً ما يؤدي إلى ظهور العديد من السلوكيات السلبية، مثل المشاكل الاسرية الناتجة عن عدم الإيفاء بالمتطلبات الأساسية للأسرة، فانعدامحاجيات الأبناء بما فيها الدراسية، تسمح بظهور جيل من البطالة والفقراء لانقطاعهم عن الدراسة، وبالتالي وجود فجوة في طموحاتهم المستقبلية وعدم ارتياح ورضى للأبناء عن أوضاعهم المعيشية،الأمر الذي يجعلهم كثيراً ما يحاولون الهروب من واقعهم المؤلم بقضاء أوقات كبيرة خارج المنزل، حيث قد يكونوا عرضة لتعلم عادات سيئة كالتعاطي.

في المقابل لذلك فإن الدخل العالي للأسرة والمستعمل في الإنفاق قد يكون عامل مساعد في عملية الاتجاه نحو الإدمان، خاصة لو توفر المال لدى الأبناء دون رقابة من الوالدين، فذلك أيضاً قد يسهل فرصة الحصول على المواد التي يعتقد الأبناء بأنها ذات علاقة بالمتعة وملء أوقات الفراغ، فيلجؤوا إلى تعاطي المخدرات، وعلى ذلك فإن المبحوثين تغيرتآراءهم البعدية فيما يخص أسباب التعاطي المعتمدة على الناحية الاقتصادية للأسرة سواء كانت فقيرة أم غنية، فكلاهما له أسبابه في الإتجاه نحو التعاطي.

الخلاصة

1. حدث تقدم لدى عينة البحث على مستوى الوقاية من تعاطي المخدرات، ويرجع ذلك إلى تفاعل الطلاب في البرنامج مع الإرشادات والتوجيهات المستخدمة سواء الحوار والنقاش أو التداعي الحر، وهو ما أثر بالإيجاب على نتائج البرنامج، ونجد أن الدرجة الكلية لإجابات أفراد العينة على المقياس ارتفعت بصورة واضحة حيث كان الوزن النسبي للمقياس قبل تطبيق البرنامج (٧٧,٨)%، بينما بعد تطبيق البرنامج ارتفع إلى (٩٥)%.
2. توجد فروق ذات دلالة إحصائية في اتجاهات عينة البحث نحو المخدرات قبل تطبيق البرنامج وبعده.
3. توجد فروق دالة إحصائياً عند مستوى (٠,٠٥) في اتجاهات المبحوثين نحو المخدرات للتطبيق القبلي للبرنامج الإرشادي تعزى لوجود متعاطي بالأسرة ، بينما لا توجد فروق دالة إحصائياً للتطبيق البعدي.

4. توجد فروق دالة إحصائياً عند مستوى (٠,٠٥) في اتجاهات المبحوثين نحو المخدرات للتطبيق القبلي للبرنامج الإرشادي تعزى لدخل الأسرة، بينما لا توجد فروق دالة إحصائياً للتطبيق البعدي.

التوصيات

1. ضرورة إقامة برامج تنشيطية متنوعة بالمدارس تجدد التثقيف الصحي بأضرار المخدرات وكيفية الوقاية منها، ويمكن إقامة مثل هذه البرامج بالمدارس في الفترة المسائية دورياً، كما يفضل تضمين المناهج التعليمية بالآثار السلبية للمخدرات وطرق الوقاية منها.

2. إقامة أنشطة رياضية وثقافية متنوعة في المدارس لملء وقت الفراغ لدى المراهقين، بعد أن اتضح أن وجود وقت فراغ قد يدفع الشباب إلى ممارسة سلوكيات صحية ضارة ومنها تعاطي المخدرات، مع ضرورة فرض رقابة شديدة على الأماكن التي يرتادونها والتأكد من ملائمتها لهم.

3. تفعيل الشراكة بين الاسرة والمدرسة فيما يخص تربية الأبناء عن طريق مجلس الآباء.

4. إنشاء مراكز وعيادات علاج واعادة تأهيل المدمنين وبالشكل الذي يضمن الاستفادة منها من حيث التوزيع وطريقة العمل.

5. تفعيل وتحديث القوانين والتشريعات الصارمة التي تحول دون انتشار المخدرات.

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Low Back Pain among Nurses in Intensive Care Unit at Selected Hospitals- Khartoum State-In Sudan (2019-2020)

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ABSTRACT

Background: Low back pain (LBP) remains one of the most common occupational hazards among the nursing profession, because the Nursing job needs combination of both physical and psychosocial demanding tasks. The main objective of this study is to determine the work related factors of (LBP) among nurses. **Methods:** Descriptive, cross-sectional, hospital based study was performed among nurses employed at eight governmental hospitals at Khartoum state-Sudan, during (October-2019-February-2020), through total coverage sampling. Modified a self-administer questionnaire was used to collect data from169 nurse aged between 20 and 49 years, of both sex. Data was collected and analyzed using SPSS version 21(confidence level 0.95and error margin (0, 05).**Results:** The prevalence of LBP was found to be (n=133, 78.8%). The factors that are significantly associated to LBP were: Female gender (n=99, 81.3%), and who performing of some risky activities such as: change the bed sheet (P = 0.00), frequently push-pull heavy objects (P =0.05), and standing for prolong period during workday (P =0.035) **Conclusion:** prevalence of LBP among nurses is high, and practices that require heavy lifting and carrying the patients, prolong standing in a work day as a part of nursing care are among the main factors that cause LBP in nurses.

Keywords: ***Low Back Pain, Nurses, intensive care unit, selected hospital, Khartoum state***

Introduction

Low back pain is one of the most serious health problem of tremendous medical and socioeconomic dimension. [1, 2, 3] With high prevalence observed especially among nursing. Since nurses carry out repetitive procedures where patient lifting aids are not always available or practicable. [4,5,6,7,8,9,10]

In occupational environment, LBP is major problem for nurses with regard to absenteeism and capacity for work, mainly in care environment

Sickness, presenters which may increase the risk of developing health disorders, productivity making these common conditions the single largest contributor to

musculoskeletal disability worldwide. LBP is defined as discomfort in the spinal area (between the lower costal margins and gluteus folds) experienced at least once a month, with or without radiation to lower limb. [2,8,11]

Intensive care unit (ICU) exhibits important risk for nurses Moreover, the ICU areas have been designated for the care of unstable patients. Heavy handling, prolonged bearing of inappropriate postures, bending twisting, working hours stress, psychological high demand and weak social support are all integral parts of the nurses' daily work. And it would be of benefit understanding the prevalence of LBP in developing nations such as Sudan.

These problems are reflected in the work environment and may affect patient care delivery. [12,13, 14,15]

Knowledge of proper lifting techniques is needed to aim at reducing musculoskeletal complaints and safe patient handling. [11, 16, 17]

This study emphasizes the important of preventive measurement for nurses career to control LBP occurrence such as :increasing number of qualified nursing staff, introducing and training in patient handling aids and devices .

Methods

Study Design

This cross-sectional hospital base study design done to assess Low Back Pain among Nurses in Intensive Care Unit at Selected Hospitals- Khartoum State-In Sudan (2019_2020)

Study area and setting

This study was Carried out at ICU' s of eight governmental hospitals as following (Khartoum, Alshaab, Dental, Dr Gaafar Ibn auf Referral Paediatric, Ibn sina, Ibrahim Malik, Altamayose Center for Trauma and Emergency and The National Center for Neurological disease and sciences)– Khartoum state-Sudan.

Data Collection:

The data collection was conducted during the period ranging from December, 2019 to February, 2020. Coverage all target population 169 /200 with eligible included criteria, using predesigned a self-administered questionnaire; consist of three parts: The first allowed collecting the general Socio-demographic data, The second part interested only the nurses with LBP with the description of their complaint The third part explored 12-month prevalence of LBP; questionnaire was-in part- rephrased and reviewed to insure that cover and satisfied the objectives of study.

Sampling and Sample size:

Coverage all target population with eligible included criteria since the required estimation sample (RSS) is near to the total population

Using a simple formula ($n = Z^2P (1-P)/ d^2$) to estimate the population proportion

P was determined at 0.80 based on the mean of prevalence in three previous studies. [18, 19, 20]

The d was set as + 0.05

The level of statistical significance, = 0.05.

Inclusion Criteria:

Included nurse (male-female) with fulltime at least working for six month pre the study.

-Nurse's age less than 50 years because older nurses will not be able to tolerate the physical demands of patient care that requires them to turn or lift

Exclusion Criteria:

Excluded nurse who experienced pregnancy three month prior to study

-Nurse with a health problems that may cause LBP e.g. (rheumatoid arthritis, history of car accident-related injuries and disc prolapsed) and menstruation

- Long-term sick leaves and long annual leave>3 month proceeding the study

Data Collection Tools:

Data was collected using a self-administered: by pre-constructed and pre tested questionnaire that was designated to include the following:

Section I: contain, socio-demographic data, which consist of eight questions such as :(age, level of education marital status, body mass index BMI).

Section II: contain questions related to risk factors of LBP which consist of nine questions such as : (years of employment and experience in ICU, working shift, standing hours per shift, lifting and carrying of heavy object, performing of some risky activities).

Section 111: The 12-month prevalence of LBP which consist of nine questions such as (what is the time when back pain first occurred, severity, frequency, Interventions performed to overcome LBP.)

Data Analysis Technique:

SPSS 21.0 was utilized for the statistical analysis, frequency distributions of responses, and cross-tabulations of individual, job risk factors were studied in association with reported prevalence of LBP. Group differences were further analyzed by the chi-square test and level of significance was determined at $p<0.05$

Data collected in four months from October 2018- February-2019.

Questionnaires were coded and transferred into especially designed formats so as to be suitable for computer feeding, following data entry checking and verification process

carried out to avoid any errors during data entry process, frequency analysis, cross tabulation and manual revision was perform.

Pilot study :

A pilot study was conducted to confirm the reliability, validity, and design to be used in the larger study, carried out on 15% of the target population, and after taking needed permission from hospitals authorities based on the feedback regarding the research objectives

Questionnaire was-in part- rephrased and reviewed to insure that cover and satisfied the objectives of study and any ambiguous or not understood question was clarified.

Ethical consideration:

The researcher full filled the necessary steps required to get the approval for carrying out the study

Result:

The response rate was 84.5% (169/200); 31(15.5%) of respondents were excluded from the study

Table 1.Socio demographic characteristics of respondents, (n=169)

Variable		**Frequency**	**Percentage (%)**
Gender	Male	47	(27.8)
	Female	122	(72.2)
Age	20 and less than 30	158	(93.5)
	30 and less than 50	11	(6.5)
Educational qualification	Diploma degree	12	(7.1)
	Bachelor degree	151	(89.3)
	Master degree	6	(3.6)
Marital status	Un married	152	(89.9)
	Married	17	(10.1)
Number of children	No child	152	(89.9)
	1-3 child	11	(6.55)
	3 and more	6	(53.6)
Body mass index	Underweight	29	(17.2)
	Normal weight	119	(70.4)
	Overweight	15	(8.9)
	Obese	6	(3.6)
Practice regular exercise or sport	Yes	63	(37.3)
	No	106	(62.7)
Smoking habits	Current smoker	12	(7.1)
	Never	157	(92.9)
Working experience	1-4 year	159	(94.1)

	5-9 year	10	(5.9)
Working shift	Morning	45	(26.6)
	After noon/ night	124	(73.4)
Means of transportation to work	On foot	38	(22.5)
	Private car	8	(4.7)
	Public transportation	116	(68.6)
	Other/bicycle	7	(4.1)

Table 2.Characteristics of LBP among Nurse Staff (N=133)

Findings about LBP	**Values** N (%)
LBP experienced in the past n =(133)	
Experienced	133(79)
Not experienced	36(21)
Duration of low back pain n =(133)	
Less than three month	92(69)
More than three month	41(31)
Time when back pain first occurred n =(133)	
Before starting the profession/job	23(17)
After starting the profession/job	110(83)
Stress level	
Mild	83(62)
Moderate	40(30)
Severe	10(8)
Diagnosed as LBP by physician n =(133	
Yes	23(17)
No	110(83)
Intervention perform to overcome low back pain1n=133)	
Bed rest	89(67)
Massage	24(18)
Exercise	9(7)
Other	11(8)
Receiving treatment for low back pain n =(133)	
Receiving treatment	43(32)
Not receiving treatment	90(68)
LBP Affects daily work activity n =(133)	

Yes	72(54)
No	61(46)
Radiated to the leg n =(133)	
Yes	14(11)
No	119(89)

Table 3. The relationship between the nurses' status of experiencing LBP and work related factors

Variables	**Occurrence of LBP n (%)**			
	Respondents with LBP (n=133)	Respondents without LBP (n=36)	Test of Significance	P value
Working experiences mean(SD) 0-4 year 5-9 year 10 years and more	 125(94) 8(6) (0)	 34(94.4) 2(5.6)	0.01	0.92
Night shift % Yes No	 97(72,9) 36(27.1)	 27(69.4) 9(30.6)	6.602	0.086
Mean of transportation to the work % On foot Private care Public transportation Other	 27(19.5) 4(3.8) 96(73.7) 6(3)	 11(33.3) 4(8.3) 20(50) 1(8.3)	0.062	0.803
Standing hour% <8 hour >8 hour	 47(35.3) 86(64.7)	 12(47.2) 24(52.8)	6.678	0.035
Perform of risky activities				
frequently lift objects above the waist% yes no	96(72.2) 37(27.8)	 21(58.3) 15(41.7)	2.550	0.110
frequently bend to lift items from floor% yes no	 101(75.9) 32(24.1)	 21(58.3) 15(41.7)	4.375	0.36
frequently change bed				

sheets while patient in the bed% yes no	 125(94) 8(6)	 15(41.7) 21(58.3)	 54.553	 0.000
frequently push-pull heavy objects% yes no	 110(82.7) 23(17.3)	 22(61.1) 14(38.9)	 7.727	 0.05
Work stress% Low Moderate High	 12(9.0) 25(18.8) 96(72.2)	 8(22.2) 5(13.9) 23(63.9)	 4.832	 0.89

Discussion

The onset of LBP during the past year in the present study is significant ($p < 0.001$),the majority (n=110, 83%) of respondents had experienced symptoms of LBP only after their professional career. supported by numerous studies; in Sudan (87.5%) of nurses experience more LBP than other hospital workers.[18]And concurred with the findings in Nigeria, [11] consistent with that in Egypt which revealed that the highest percentage of LBP was found among ICU's nurses (95.0%). 100% of cases, it had occurred within the last 12 months. Probably because all most of the participant were new graduate with experiences less than 4 years. Closed to that literature. [4, 19,20]

The current study result has shown that majority of the sample (125.94%) complained of LBP within 1-4years' experience (P>0.05), in accordance to the literature. [21, 22] This is probably due to the younger age distribution of respondents in the present study as the nurses in the first group were unaccustomed to the work activities; there was no conditioning to the muscles which caused more discomfort. possible explanation that with experience, nurses learn how to protect their backs, and by the time they become fit and make right decision about their abilities .these results were in agreement with those of. [23, 24]

Smoking was not significant predictor for LBP p value>0.05 in current study may since that the sample comprise were predominantly female (122, 70.4%) similar finding in those study. [4, 15] In contrast to. [25]

The current study revealed a protective effect of practicing regular exercise on developing LBP. Similar results was reported by several authors. [11, 19] Because daily exercise helps

to maintain and strong back muscles so that it can be adapted with sudden force and thus decreases the frequency and severity of LBP against abnormal forces.

On the other hand, there is a high percentage among those with LBP who had worked night shift, and among those who used public transportation to the work, one possible explanation , Nurses were standing up for long periods of time, working in wrong posture for long time, disruptions of sleeping cycle and eating habits. This statement is in accordance with the results of a study conducted in Korea. [26]

LBP in present study, particularly high among nurses who had to perform the risky activities; repositioning the patient, bending for word, push pull respectively probably could be due to most of these respondents were un able to apply PBMs while performing these physical tasks, shortage of qualified nursing and lack of patient handling aids, This result was in accordance with those. [3,27,28] That carrying loads over 10 kg was associated with pain duration over one day, visit to a health professional and taking a treatment for LBP

[32, 33]In a line to previous studies

The frequent repositioning of patients in bed up to nine times per shift was also found to be significantly associated to LBP. [3, 16] This supported the current study findings.

Standing for more than eight hours associated with LBP in current study there is a strong association between standing hours and LBP (P value<0.05). These findings supported with previous studies. [16] Which have characterized the postural alterations that occur during prolong standing and postural orientation deficits.

There was a positive relationship between perceived stress level and the occurrence of LBP in current study (96,72.2%) ,in high stress level psychosocial work factors may lead to work stress which produces physiological reactions such as increased muscle tension in the lower back causing LBP .[28]

Conclusion

- This study indicates that LBP was a common health problem among nurses studied
    - It was more prevalent among those with short year experience, working in shifts with long standing hours and performing of risky activities
    - Study found that better educated staffs were more likely to be involved in direct patient care.

- Preventing LBP in nurses is important in order for nurses to exercise their fundamental right to work under healthy and safe conditions and to provide better support for the patients. So necessary individual and institutional precautions should be taken

- Recommendation

The findings of this study indicated that nurses need to take precaution to prevent LBP from occurring. In order to prevent LBP at a later stage of their career.

- Implementation of patient handling regulations, team lifting when required and training nurses, in both schools and workplaces, on handling weights and on using mechanical aids in everyday work, is essential.
- Nurses who first join the work force have to be made aware of this potential occupational hazard and take precaution from the start of their nursing career.
- Nurses need to use assistive devices whenever possible in patient handling tasks. Have to learn and be discipline in performing back-strengthening exercises.
- Preventive measures should be taken to reduce the risk of LBP, such as arranging proper rest periods, educational programmed to teach the proper use of body mechanics, improving nurse staffing, reducing the frequency of night shifts and assessing risk factors in specific ICU specialties are suggested to decrease back pain prevalence.

. Study Limitations

- It is a cross-sectional study concerning loss of objectivity. However, self-reporting is the main approach to study symptomatic disorders, especially considering the subjective nature of symptoms of low back pain. And The physical examination does not always allow a diagnosis and its validity can be questioned as there is no gold standard method for comparison An important source of potential bias in occupational cohort studies is the healthy worker) .[29]

Acknowledgements

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Perception of Nursing Students towards E - Learning in Selective Private University during the Covid 19 at Khartoum State – Sudan (2022)

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Abstract

Background: Electronic Learning has received widespread acceptance in recent years due to the outbreak of the COVID-19 pandemic. It appears that there is universal agreement that the worldwide e-learning market will show fast and significant growth over the next three years. **Aim:** The study set out to recognize the perceptions of nursing students about E-learning. In selected private nursing colleges at Khartoum State-Sudan. **Methods:** Descriptive cross-sectional design. The study includes (230) students which had been selected by stratified sampling technique. A self-administered questionnaire was used for data collection, Data analysis was done using the statistical package for social sciences (SPSS version 26) and the results were presented in descriptive and numerical forms as well as cross tables. **Results:** Findings revealed a high level of perception about online classes. The study explains that the majority of the study population has the technology to access the E - learning materials. While 85.7%of the study population knows the definition of eLearning correctly. The data indicated that a third of the study population downloaded materials of E-learning platform very easily a mean (3.88). The study justifies that less than fifty percent of the study population mentioned that the language of the module & courses is easy to understand with the mean (3.26). **Conclusion:** The study depicts that nursing students had a positive disposition toward eLearning. The study revealed that e-learning has benefited from a student's perception, it has a positive influence on their performance with a better understanding of their courses.

Keywords: E-learning, Perception, Nursing, students

Introduction

Electronic learning [e-learning] can be defined as education that integrates electronic equipment and tools and the interactivity that occurs between these and the people involved in the educational process (i.e. instructors and learners). More

and more E-Learning projects are being developed lately and some spectacular successes are recorded [1] .

Electronic learning (e-learning) is changing the way teaching and learning is taking place on university campuses. As e-learning is a relatively new phenomenon, currently both educators and students are struggling with the idea of its implementation and adaptation respectively [2] .

It is argued that the achieved outcomes from traditional education and training programs are quite often far from ideal.so the institutions have to find a new way of learning and developing a new system to manage the flow of knowledge [3,4].

E-learning facilitated and supported the learning process through information and communication technologies (ICTs). The use of Information Technology (IT) has impacted how things are done, and its influence on teaching and learning, thus becoming increasingly complex and widespread [5,6].

E-learning systems are multidisciplinary, where the success of E-learning depends on two factors (The technological factor, i.e. software and hardware that are used to build the E-learning system, And the Human factor, i.e. students and instructors [7].

Globally, online learning has become the present-day paradigm shift in higher institutions of learning [8]. These swift developments in education technology have not only altered the contemporary way of life but have deeply affected the manner of teaching and learning [9]. Studies have revealed that Students learn faster and retain about 25-60% when learning online compared with 8-10% in classroom teaching. In addition, it has been documented those learners learn at their own pace, and they were able to do personal revisions on what has been taught. Online teaching provides several opportunities to develop the learning atmosphere for different learners' populaces, and has inspired students to be more accountable for their acquisition of knowledge [10, 11].

Methodology

Study Design

Descriptive cross-sectional university-based study

Study Area:

The study was carried out at selected private nursing colleges that implemented the E-Learning program in Khartoum. The total number of private nursing colleges was 29. They found all the available colleges in Khartoum State at the time of the study. The study was conducted in three private nursing collages in Khartoum State,

Settings:

International University of Africa (IUA): It was established1966 and is located in Khartoum Madni street. It has 22 faculties The college of nursing science established in 2006, consist of 15 batches, 423 students, and graduated 11 batches.

National University –Sudan: It was founded in 2007 and is located in the metropolis of Hama. College of nursing science established 2007 consist of 11 batches,272 students and graduated 9 batches

Nile University: It was established in 2007, located in Khartoum inside an urban campus, It has 7 faculties, the college of nursing science it established in 2007, consist of 14 batches, 360 students, and graduated 10batches.

Study population:

Nursing students in three selected private nursing colleges, they implemented E-learning in the class.

Sample size & Sampling techniques:

The sample was measured by the simple equation

n = N/1+N(d2) =539/1+539(0.05)2=230

Where n is the sample size

N=population

d is the degree of accuracy or level of precision (is usually set to 0.05).

The number of students in the above colleges is about 539=539/1+539(0.05)2=230

The sample was distributed proportionally to the actual simple size of each college.

The colleges	No of students	Percentage	Sample size
Nile university	116	21.3%	49
International University of Africa	151	28.3%	65
National University-Sudan	272	50.4%	116
Total	539	100%	230

The sample was be selected by probability sampling techniques (stratify sampling)

Variables of the study

Dependent

Student's perception of E-Learning

Independent:

Demographic characteristic

Age, gender. and level of education

Data collection and technique:

Data were collected through interviews with the study population by using A self-administered close-ended questionnaire within two months after a signed consent by the participant. The questionnaire consisted of four parts that addressed the formulated research questions.

Part one: included items on the -demographic characteristics of the study population.

Part two: consisted of questions that addressed E. learning and the effectiveness of platform uses for E. Learning.

Part three: This part measures the student's perception and knowledge about E-learning. Likert Scale was used it contains five questions including fives scales (Strongly Disagree, Disagree, neither agree nor disagree, Agree, Strongly Agree.)

Validity and reliability

The tool was examined by expertise in the field of the study and their comments about Content and context were considered. Piloting was done among 30 students and was analyzed to check for reliability. The reliability of the instrument was achieved by subjecting the questionnaire to Cronbach's Alpha test. The study finds that the coefficient of greater consistency and honesty (65%), achieves the purposes of the research.

Data analysis:

The data gathered was analyzed using Statistical Package for Social Sciences (SPSS) version 26. Based on the research questions raised at the onset of the study, the analysis was divided into two sections: demographic characteristics (which were analyzed Descriptively using frequency counts and percentage distribution) and the rest of the questionnaire (which was analyzed by mean, Standard deviation, and chi-square test) Study results were presented in form of tables

Ethical considerations:

The researcher obtained approval to conduct the research; from the following authorities:

-Alneelian institutional reviewer board

- Selected private nursing colleges

- Research purpose and objectives was explained to participants in clear simple words

- Participant has the right to agree or refused.

Results

Table (1) demographic characteristics of study population

Personal Information	Frequency	Percent
Gender		
Male	14	6.1%
Female	216	93.9%
Total	**230**	**100.0%**
Age		
18-20 year	111	48.3%
21-23 year	105	45.7%
27-30 year	13	5.7%
30 Above	1	0.4%
Total	**230**	**100.0%**
Level of study		
Level one	45	19.6%
Level two	9	3.9%
Level three	104	45.2%
Level four	72	31.3%
Total	**230**	**100.0%**

Table (2) Accessibility to E-Learning materials

	Yes		No		Total
	F	%	F	%	
I have the technology to access the material.	197	85.7%	33	14.3%	230(100%)
I have time to access the online materials.	158	68.7%	72	31.3%	
I know how to access the materials provided online by the teacher.	178	77.4%	52	22.6%	
I know how to navigate through the e-learning web-based module.	134	58.3%	96	41.7%	
E-Learning defines as any form of education that is facilitated by the internet and its technologies, to support instruction and to deliver course content.	197	85.7%	33	14.3%	

Table (3) knowledge of participant regarding definition of E-Learning

Statement	correct		incorrect		Total
	F	%	F	%	
E-Learning defines as any form of education that is facilitated by the internet and its technologies, to support instruction and to deliver course content.	197	85.7%	33	14.3%	230(100%)

Table (4) The effectiveness of platform of E-learning

Items		Very Easily	Easily	Undecided	will try	I can't	Mean
Post messages	**F**	82	85	30	20	13	3.88
	%	35.7%	37.0%	13.0%	8.7%	5.6%	
Attach files to e-mails	**F**	57	82	31	40	20	3.50
	%	24.8%	35.6%	13.5%	17.4%	8.7%	
The student form	**F**	64	77	45	35	9	3.66
	%	27.8%	33.5%	19.6%	15.2%	3.9%	
Downloading materials	**F**	88	78	24	27	13	3.87
	%	38.3%	33.9%	10.4%	11.7%	5.7%	

Table (5) The perception of nursing students about online learning

Items		Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree	mean
The language of the module is easy to understand.	F	23	112	27	37	31	3.26
	%	10.0%	48.7%	11.7%	16.1%	13.5%	
	%	10.4%	38.7%	19.6%	22.6%	8.7%	
It is easy to do my tasks with the e-learning web-based module.	F	18	86	57	47	22	3.14
	%	7.8%	37.4%	24.8%	20.4%	9.6%	
Internet connection is not a problem for me.	F	25	54	36	71	44	2.76
	%	10.9%	23.5%	15.6%	30.9%	19.1%	
The online forums case my interactions with colleagues and the teacher.	F	23	78	53	50	26	3.10
	%	10.0%	33.9%	23.0%	21.7%	11.3%	
I often encounter technical problems with the e-learning web-based module.	F	22	93	43	48	24	3.18
	%	9.6%	40.4%	18.7%	20.9%	10.4%	
There is flexibility in time and space for learning.	F	41	82	49	41	17	3.39
	%	17.8%	35.7%	21.3%	17.8%	7.4%	
It is easy and quick to access and share educational material.	F	40	96	37	38	19	3.43
	%	17.4%	41.7%	16.1%	16.5%	8.3%	
It improves collaboration and interactivity among students.	F	30	79	38	60	23	3.14
	%	13.0%	34.5%	16.5%	26.1%	10.0%	
Do you motivated and enthusiastic about learning through online.	F	33	83	42	45	27	3.22
	%	14.3%	36.1%	18.3%	19.6%	11.7%	

Table (6) The student perception towards the role of teacher in facilitating E-learning

Items		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Mean
The teacher's online instructions are easy to understand.	F	20	93	45	46	26	3.15
	%	8.7%	40.4%	19.6%	20.0%	11.3%	
The teachers conduct question and answer activities about the learning material through online Learning.	F	14	98	35	57	26	3.07
	%	6.1%	42.6%	15.2%	24.8%	11.3%	
The teachers explain material well through online Learning.	F	24	89	45	52	20	3.20
	%	10.4%	38.7%	19.6%	22.6%	8.7%	

Table (7) Relationship between platforms and Student's perception about E-learning by Level

		Sum of Squares	df	Mean Square	F	P.value
The effectiveness of platform for E-learning	**Between Groups**	6.896	3	2.299	2.887	0.036*
	Within Groups	179.925	226	0.796		
	Total	186.822	229			
Student's perception about E-learning	**Between Groups**	5.141	3	1.714	3.117	0.027*
	Within Groups	124.233	226	0.550		
	Total	129.374	229			
	Within Groups	72.426	226	0.320		
	Total	72.783	229			

Table(8) The relationship between platform and Student's perception about E-learning by Gender

Gender		N	Mean	SD	T	df	P.value
The effectiveness of platform uses for E-learning	Male	14	3.64	1.277	-0.950	228	0.343
	Female	216	3.88	0.876			
Student's perception and about E-learning	Male	14	2.86	1.099	-2.043	228	0.042*
	Female	216	3.28	0.720			
	Female	216	2.39	0.568			

Discussion

This thesis set out to analyze the perceptions of students about e-learning, as they are the main beneficiaries of this technology-enabled learning. Perceptions were sought concerning how students understand e-learning and their views on its uses. The study covers the effectiveness of platforms in e-learning and students can use the various technologies and tools that enable them to successfully participate in e-learning. Regarding personal information, the study revealed that (45.2%) of the study population was in level three and most of them were female (93.9%) while less than half (48.3%) of the study population belong to the 18-20 age group.

Furthermore, the study explains that the majority of the study population has the technology to access the material. wihle85.7% of the study population know the definition of eLearning correctly. These findings agreement with the study done in Ghana it was found that more than fifty percent of respondents in the sample were comfortable using information technology for various activities, while less than fifty do not [12]. another study was done in Chennai it was found that the maximum

number of students are aware of E-Learning and the technology as an important part of their daily activities [13].

The data indicated that a third of the study population downloaded materials with a mean (of 3.88). This is justifying that less than fifty percent of the study population understands the language of the module with their mean (3.26)

The study revealed that no significant relationship between platform uses for E-learning and students' perception of E-learning.

There was a significant relationship between the Level of study population and platform uses for E-learning P. (0.036)

Regarding The student perception towards the role of teacher in facilitating E-learning, The study revealed that students agree the teachers explain material well through online Learning mean (3.20). this finding reflects the ability of teachers to communicate via the internet, accessing and publishing information is very diverse.

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Molecular Detection of *Human Papilloma Virus* Type 16 and 18 among Sudanese Patients with Prostate Mass

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Abstract:

Background and Objective: Despite the rising number of research recently conducted to assess the association between *Human Papillomavirus* **(***HPV)* infections and prostate cancer, the results remain disputed; therefore, we try to investigate the possible role of HPV 16 and 18 as a risk factor for prostate cancer and benign prostatic hyperplasia in Sudanese patients. **Method:** This is a cross-sectional retrospective study conducted on formalin fixed paraffin wax embedded (FFPE) tissues, retrieved from the archives of histopathology Laboratory at Omdurman teaching hospital (Sudan). 200 samples of FFPE prostate tissue blocks from 2020 to 2022 were selected for this study. A 100 were prostate adenocarcinoma and 100 were benign prostatic hyperplasia. All samples were of Sudanese ethnic, sections of 10 µm prepared by sterile microtome blade, and then deparaffinized and the DNA extracted chemically and stored at - 20 °C. HPV 16 and 18 was investigated on all samples using PCR. The data analyzed by Statistical Package for the Social Sciences (SPSS) software version 19. **Results:** The results showed that *HPV*-16 was positive in 6(6%) of the adenocarcinoma and 4(4%) of the hyperplasia. The difference of *HPV*-16 infection between prostate adenocarcinoma and benign prostatic hyperplasia was statistically in significant (*P. Value* 0.374). *HPV*-18 was positive in 2(2%) of the adenocarcinoma and 4(4%) of the hyperplasia also with no statistical significant difference *(P. Value* 0.341), also there was in significant statistical correlation between HPV type 16 and 18 with prostate cancer grade as the p. value was (0.60 and 0.925) respectively**. Conclusion:** These findings excluded the role of *HPV* 16 and 18 in prostate cancer in Sudanese.

Keywords: Molecular detection; HPV 16 and 18 ; prostate masses ; Sudanese men

1. Introduction:

Prostate Cancer (PCa) is the commonest male cancer worldwide and represents a significant healthcare challenge. Many epidemiological studies on prostate cancer reported a positive

association between risk of prostate cancer and history of sexually transmitted diseases. [1, 2] However, sexual history is not related directly to exposure to specific microorganism and this association may vary between populations. An involvement of specific sexually transmitted diseases in prostate cancer has been sought for decades. Positive associations are reported with gonorrhea, syphilis, and *Human Papillomavirus* (*HPV*) infections.[1, 3-6] Studies suggested a possible links between HPV infections and prostate cancer risk factor, because of their link to cervical carcinoma. In addition to female's specific cancers, *HPV* associated with the risk of male anogenital and urinary cancers, such as penis, bladder and anus, [7] thus it hypothesized that the prostate gland may be infected by *HPV* for its anatomic proximity.

Human papillomavirus (*HPV*) are a group of genetically related viruses that infect epithelium leading to proliferative changes result in both benign and malignant tumors. [8] *HPV* are small non enveloped viruses with 55-nm-diameter icosahedral capsids contain double-stranded DNA of approximately 8,000 bp. [9] More than 200 different HPVs now have been characterized, and new types are regularly added to this list.[9] It reported that 15% of all cancers are due to viral infection. [10] Evidence for the etiological role of *HPV* in urological malignancy is squamous cell carcinoma of the penis [11]. Approximately 40 types associated with anogenital tract lesions. Infection with high-risk (oncogenic) types of *HPV* (HPV type 16, -18, -31, -33, -35, -39, -45, -52, -56, -58, and -68) is a well established risk factor for cervical and other anogenital malignancies while low-risk HPVs associated only with benign genital warts[12].

There are three regions in *HPV* genome. The first region is long regulatory region contains the promoter and the DNA replication regulator sequences. The second region involved in virus replication and carcinogenesis it contains E5, E6 and E7 that have been identified as oncoproteins. The third region encoding the L1 and L2 structural proteins for virus encapsulation[13], the proliferation of infected cells regulated by the action of *HPV E5* with a transmembrane lipoprotein of the endoplasmic reticulum [14]. *HPV E6* destroys the p53 tumor suppressor, whereas *HPV E7* destroys the *RB* tumor suppressor [15]. Oncoproteins *E6* and *E7* in *HPV* type 16 and 18 are the main cause of prostate epithelial cell accumulation [16]. Although several studies suggested that there is no association between HPV and prostate cancer because high-risk HPVs have a similar prevalence in benign and malignant prostate tissues, various studies reported differences in *HPV* expression. Conversely, Serth *et al*. [17] reported a significantly high number of *HPV*-16-E6 sequence copies in prostate cancer compared with prostate adenomas suggesting that *HPV*- 16 play an important role in

tumorigenesis. Thus considering *HPV* as an etiological factor for PCa still remains controversial not substantiated a firm link yet. In Sudan Ahmed Abdulmajed Merghani *et al* [18] in their inspiring paper reported significant association between *HPV* 16 and *HPV* 18 and Prostate cancer by immunohistochemical methods on 50 formalin fixed paraffin embedded biopsies, 18 of them were PCa tumors and 32 were benign prostatic hyperplasia (BPH). Therefore we try to investigate the possible role of *HPV* 16 and 18 as risk factor for prostate cancer by using polymerase chain reaction (PCR).

2. Methodology:

2.1. Study design and population:

This is a cross-sectional retrospective study on formalin fixed paraffin wax embedded (FFPE) tissues retrieved from the archives of Laboratory of Omdurman teaching hospital (Sudan). A well saved 200 samples of FFPE prostate tissue blocks in the period from 2020 to 2022 were selected randomly for this study. Based on their accompanied medical records 100 are prostate adenocarcinoma and 100 are benign prostatic hyperplasia. All samples were of Sudanese ethnic origin. None of them had received radiotherapy or chemotherapy.

Five serial sections of 10 µm thick were taken from each biopsy using a new blade between each sample to avoid cross-contamination. The three internal sections placed in an Eppendorf tube for DNA extraction while the two outer sections were stained with Hematoxylin (Harris) and Eosin and reexamined by a consultant pathologist to confirm diagnosis. The ethical permission was granted from Omdurman teaching hospital.

2.2.DNA extraction:

On Day 1 of the DNA extraction, tissues were incubated in xylene at 45°C for 15 minutes allowing the wax to dissolve. Samples were then centrifuged for 10 min at 14,000 rpm. The resultant supernatant is pipetted off, leaving the wax in the bottom of the tube. The latter steps were repeated once more. Then 1 ml 100% ethanol was added to the tissue pellet, vortexed and then centrifuged for 10 min at 14,000 rpm, and the supernatant pipetted off. 1 ml 90% ethanol was added to the tissue pellet, vortexed, centrifuged for 10 min at 14,000 rpm, and the supernatant pipette off. The same step was repeated, with 70% ethanol this time. The resultant pellet was then dried in a speed vac. Pellet is resuspended in 400 µl of DNA extraction buffer. 40 µl of Proteinase K (10 mg/ml) was added, vortexed briefly, and incubated at 55°C overnight to get rid of the protein. On Day 2 of DNA extraction experiments, 440 µl of phenol was added and was shaken vigorously by hand for 5 min, and centrifuged for 5 min at 8000 rpm. Supernatant was transferred into a new tube, a solution of

220µl phenol plus 220µl chloroform/isoamyl alcohol (24:1) was then added, shaken vigorously by hand for 5 min, and centrifuged for 5 min at 8000 rpm. The aim was to get rid of the Phenol. Again, the supernatant was transferred into a new tube, 440µl chloroform/isoamyl alcohol (24:1) was added, shaken vigorously by hand for 5 min, and centrifuged for 5 min at 8000 rpm, to get rid of chloroform/isoamyl alcohol. Then, the resultant supernatant was transferred into a new tube (2 ml Eppendorf tube), and 1/10 volume of sodium acetate (pH 5.2) was added. In addition, 3 volumes of ice-cold 100 % ethanol were added, and the tube was kept overnight at –20°C. By day 3 of the DNA extraction experiments, the tubes were centrifuged for 30 min at 4°C and the supernatant was removed. The pellet was dried in a speed vac. 20-50 µl sterile water was then added. Tubes were then shaken gently in a thermo mixer at 37°C for 2 hours.

Then Nanodrop (ND-1000) spectrophotometer was used to quantify the DNA concentration as follows the device was adjusted to 40ng /ul and was firstly blanked using 1ul of the same solvent in which DNA was dissolved. After good vortexing and mixing up and down using a pipette, 1ul of DNA was taken. The Nanodrop stages were cleaned well by wiping them with a clean dry tissue between each reading. For each sample, three readings were taken by increasing the taken amount from DNA by 0.5 ul each time than the average for the three readings was calculated.

2.3.Detection of *HPV*16 and *HPV*18 by using PCR :

The PCR was performed in 25 µl reaction mixtures. Thermal cycling of the amplification mixture was performed in the gradient PCR for a total of 35-40 cycles. The cycle represents denaturing for 1 minute at 94˚C, annealing for 1 min at 49˚C for *HPV*16 and 44˚C for *HPV*18, and a primer extension for 1 min at 72˚C. The name and sequences of primers as well as the length of PCR products are shown in Table 2.1. The thermal cycler was programmed for 40 cycles with an initial denaturation at 94°C for 4 min. At the end of the last cycle, the mixtures were incubated at 72°C for 10 min. The amplified products assessed by electrophoresis on a 1% (w/v) agarose gel in 1× Tris-borate-EDTA buffer at a pH of 8.6. The gel was stained with ethidium bromide of 10 mg/ml 2 µL in 100 mL of 1× Tris-borate-EDTA, and the amplified bands were visualized on an ultraviolet transilluminator.

Table 2.1. Name and Sequences of Primers Used in PCR Tests, the Target Gene, and the Length of PCR Products in Base Pairs (Bp). [19]

Primer Name	Primer Sequence	Target	Length of PCR Product in Base Pairs (bp)
F - 16	*TTATGAGCAATTAAATGACAGCTCAG*	*HPV* - 16 (E7 gene)	215 bp
R - 16	*TGAGAACAGATGGGGCACACAAT*		
F - 18	*GACCTTCTATGTCACGAGCAATTA*	*HPV* - 18 (E7 gene)	236 bp
R - 18	*TGCACACCACGGACACACAAAG*		

2.4. Statistical Analysis:

The data were revised then entered into the Statistical Package for the Social Sciences (SPSS) software version 19 and analyzed by Chi -square. P values less than 0.05 were considered statistically significant.

3. Results:

Table 3.1: HPV-16 detection by PCR in prostatic adenocarcinoma and benign prostatic hyperplasia groups (N= 200)

HPV-16	Adenocarcinoma	Hyperplasia	Total
Positive	6 (6%)	4 (4%)	10 (5%)
Negative	94 (94%)	96 (96%)	190 (95%)
Total			200

P. Value **0.374**

Table 3.2: HPV-18 detection by PCR in prostatic adenocarcinoma and benign prostatic hyperplasia groups (N= 200)

HPV-18	Adenocarcinoma	Hyperplasia	Total
Positive	2 (2%)	4 (4%)	6 (3%)
Negative	98 (98%)	96 (96%)	194 (97%)
Total			200

P. Value **0.341**

Table 3.3: correlation between HPV-16 and adenocarcinoma grade (N=100)

Grade	HPV-16	Total

	Positive	Negative	
3+3	3(3%)	26(26%)	29(29%)
3+4	0(0%)	3(3%)	3(3%)
3+5	0(0%)	2(2%)	2(2%)
4+3	1(1%)	20(20%)	21(21%)
4+4	2(2%)	13(13%)	15(15%)
4+5	0(0%)	12(12%)	12(12%)
5+2	0(0%)	1(1%)	1(1%)
5+3	0(0%)	3(3%)	3(3%)
5+4	0(0%)	8(8%)	8(8%)
5+5	0(0%)	6(6%)	6(6%)
P. Value	**0.860**		

Table 3.4: correlation between HPV-18 and adenocarcinoma grade (N=100)

Grade	**HPV-18**		**Total**
	Positive	**Negative**	
3+3	0(0%)	29(29%)	29(29%)
3+4	0(0%)	3(3%)	3(3%)
3+5	0(0%)	2(2%)	2(2%)
4+3	1(1%)	20(20%)	21(21%)
4+4	1(1%)	14(14%)	15(15%)
4+5	0(0%)	12(12%)	12(12%)
5+2	0(0%)	1(1%)	1(1%)
5+3	0(0%)	3(3%)	3(3%)
5+4	0(0%)	8(8%)	8(8%)
5+5	0(0%)	6(6%)	6(6%)
P. Value	**0.925**		

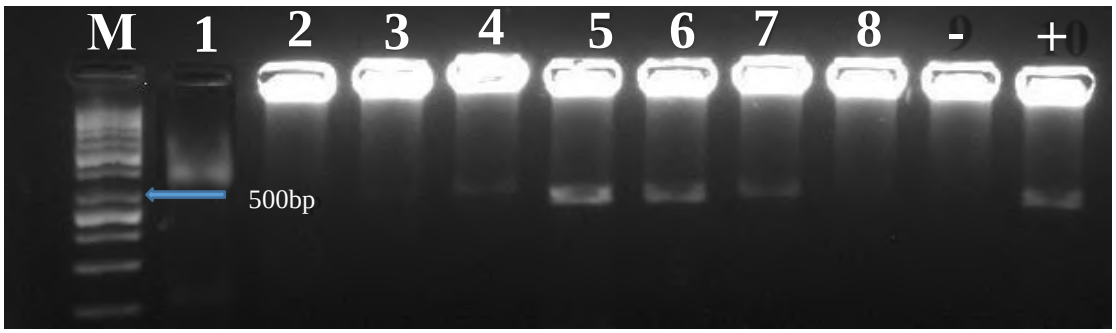


Figure 3.1: *HPV*16 PCR assay (215 bp). M = DNA molecular weight marker. Sample of positive PCR- reactions are seen in specimens 5, 6, and + = positive control, - = negative control

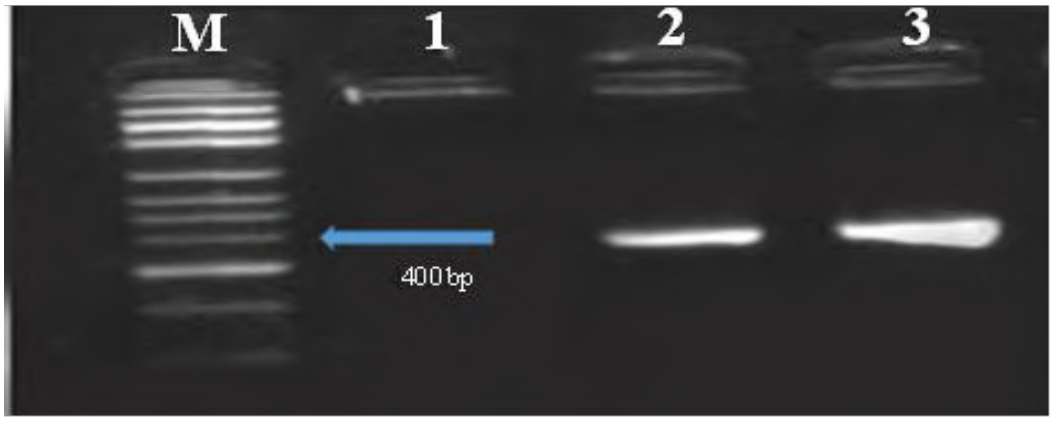


Figure 3.2: *HPV*18PCR assay (236 bp). M = DNA molecular weight marker. Sample of positive PCR- reactions are seen in specimens 3 and 1 = negative control, 2 = positive control.

4. Discussion:

Prostate cancer is the second most common cancer in men worldwide. [20] The incidence rate is the highest in African men followed by European and Asian. [21] In Sudan (Khartoum) among all cancer sites, prostate cancer ranked fourth and first among Sudanese men aged 65 years and older. [22] Despite all research efforts the risk factors for prostate cancer is still unclear, it has a multi-factorial origin with environmental, dietary and genetic factors reflecting its complex pathogenesis. Hamad, [23] 2011 in Gezira state, Sudan found the risk factors for prostate cancer include age, education level, occupation, unhealthy habit such as smoking and obesity. In addition to these factors, sexually transmitted disease considered one of the more consistently risk factors.[24] Recently, *HPV* types 16 and 18 specific DNA

sequences detected in prostate cancer biopsy. Since HPV types 16 and 18 are known oncogenic potential, an association between *HPV* infection and prostate cancer has been suggested. [25] Its oncogenicity is due to persistent infection and expression of viral proteins, E6 and E7, that inhibit cellular tumor suppressor gene such as *Rb*, and *p53*. [26]

According to available published literature this is the first study in Sudan to investigate the possible role of *HPV* 16 and 18 in prostate cancer through DNA detection using polymerase chain reaction (PCR). The study included 200 samples of FFPE prostate tissue blocks, 100 are prostate adenocarcinoma and 100 are benign prostatic hyperplasia (BPH). In the present study, the histological type of prostate cancer was adenocarcinoma which is compatible with the result of a meta analysis by Yang L, *et al*. [27] also from 16071 cases of prostate cancer in Iran during (2003 - 2008), (95.2 %) of them were adenocarcinoma [28]

The results of the current study showed that HPV-16 was positive in 6(6%) of the adenocarcinoma patients and 4(4%) of the hyperplasia patients. The difference of *HPV*-16 infection between groups was not significant (*P. Value* 0.374). HPV-18 was positive in 2(2%) of the adenocarcinoma patients and 4(4%) of the hyperplasia patients, with no significant difference *(P. Value* 0.341). However these findings were supported by Noshin Abdolmaleki, *et al* [29] , Adami HO, *et al* [30] , and Merve Aydin, *et al* [31] in their studies which concluded that no association between *HPV*-16 and 18 and prostate cancer. Two Meta - analyses studies reported significant association between *HPV* infection and the risk of prostate cancer, these results were not consistent with our findings [32, 33], these discrepancies may be due to varied distribution of *HPV* among different populations, differences in methods of prostate tissue sampling, the sample size, PCR analysis, in situ hybridization, immunohistochemistry or southern blot hybridization analysis. Also duration of specimen storage before fixation, the age of the tissue and blocks can all influence the integrity of stored DNA. In conclusion, these findings excluded the role of *HPV* 16 and 18 in prostate cancer in Sudanese. Also may reflect low prevalence of *HPV*.

Limitations:

As in all research, there are certain limitations in this study; the most important is that comparative group consisted of samples with BPH; however it should be normal prostate tissue to assess the role of HPV infection in prostate carcinogenesis appropriately. We did not have access to these samples.

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Funding:

None

Conflicts of interest

No conflicts of interest.

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Polymorphism of insulin receptor gene His1058 and its association with insulin resistance among women with polycystic ovary syndrome

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Abstract

Insulin resistance is a central key element contributing to polycystic ovary syndrome (PCOS) pathogenesis and is further aggravated by obesity. Various mutations with the insulin receptor (INSR) gene can result in the clinical manifestation of insulin resistance. This study aimed to assess insulin receptor gene rs-1799817 polymorphisms and its association with fertility hormones among women with PCOS. **Methods**: This case control study was based on (150) Sudanese women with PCOS and (150) healthy females (control group). ASYS Expert Plus Microplate was used to quantify serum luteinizing (LH), follicle-stimulating hormone (FSH) levels in fasting blood specimen drawn during the follicular phase of the menstrual cycle of women with PCOS. The serum insulin was measured using ELISA and glucose concentrations measured using Cobas 311c, Insulin resistance was calculated by the homeostasis model (HOMA-IR). The guanidine extraction procedure was used to extract genomic DNA from EDTA whole blood. Genotyping for insulin receptor gene (rs-1799817) polymorphism by using polymerase chain reaction-restriction fragment length polymorphism (PCR-RFLP). The data obtained were subjected to analysis using statistical package for social science computer program (SPSS version 26). **Results:** The results revealed PCOS women had a significant increase in insulin hormone, HOMA-IR (P-value=0.000), while there was insignificant difference in FBG (P-value=0.513) when compared with non-PCOS group. Study revealed that there was insignificant variation in genotypes of (rs-1799817) between case and control groups. Although, 9.7% (14/144) of PCOS group had mutant genotypes (TT) compared to 6.5% (9/139) in control group. **Conclusion:** The study showed a high level of LH, FSH and insulin in PCOS patients, associated with increased incidence of TT genotype (rs-1799817) polymorphism among women with PCOS.

Keywords: PCOS, insulin hormone, HOM-IR, Insulin receptor gene His1058, Genotype

Introduction:

PCOS is the most common endocrinological problem among women of reproductive age, is characterized by chronic ovulatory dysfunction, hyperandrogenism, and infertility. PCOS, affecting (8–13%) of women of reproductive age globally[1].

Although the etiology of PCOS is still not well known[2], it seems that insulin resistance is a major pathophysiologic mechanism in developing clinical symptoms and other metabolic complications of PCOS[3]. Resistance to insulin leads to an increase in free androgen availability, and consequently alteration in follicular development and granulosa cell function [(4-5)]. Insulin resistance is universally accepted as a key pathophysiologic feature of PCOS and metabolic syndrome, regardless of obesity[6].

Different genes have been implicated in insulin action and are used as biomarkers for PCOS. INSR is considered as a candidate gene for PCOS susceptibility[7]. The INSR gene is located on chromosome (19) and it consists of (22 exons and 21 introns). The exons (17–21) encode the tyrosine kinase domain of the receptor, which is necessary for insulin signal transduction [8]. Mutations in these exons can cause insulin resistance and hyperinsulinemia[(9-10)].

Materials and Methods:

Study participants:

This was comparative case control hospital-based study. It was conducted in Saad Abu-alela Hospital, Banoon Medical Center, Nile Fertility Center, Royal care hospital, East-Nile hospital, Sudan Assisted Reproductive Clinic and Dr. Elsir Abu-Elhassan Center among (PCOS) patients. It was carried out over (2 years).

Ethical clearance

The study was approved by the internal review research board at Sudan University of Science and Technology. The objectives of the study were explained to all individuals participating in this study. Verbal consent was obtained from all participants in the study.

A total of (150) patients diagnosed with polycystic ovary syndrome, and (150) controls (age was matched) were enrolled in the study, after obtaining written informed consent.

Polycystic ovary syndrome women who are clinically diagnosed according to Rotterdam criteria enrolled in this study. All patients previously diagnosed with disorders that can result in menstrual irregularity and hyperandrogenism, including adrenal or ovarian tumors, thyroid

dysfunction, congenital adrenal hyperplasia, hyperprolactinemia, acromegaly, type 2 Diabetes M mellitus and Cushing's syndrome were excluded.

Biochemical measurements:

After obtaining informed consent from each participant a sample of venous blood (5 mL) was collected and then divided into three containers, (2 ml) of blood was collected in plain container to obtain serum after centrifugation for insulin hormone, (2 ml) of blood was collected in fluoride oxalate for glucose and (2 ml) of blood was collected in EDTA container (whole blood) used for DNA extraction (glucose and insulin hormone from fasting patients).

The collected blood samples were immediately centrifuged, and the serum was stored at (-80 °C) until further analysis. ASYS (model: Expert Plus; type G020150; serial nr: 28382; Austria) was used to quantify serum LH, FSH by indirect method. The insulin levels were measured by ELISA. Cobas c311Analyzer was used to measure plasma glucose levels. HOMA-IR was calculated using the formula: glucose (mmol/L x insulin (mU/L)/22.5.

Genetic analysis:

Polymerase Chain Reaction (PCR) was used to amplify INSR gene SNP (His1058) and the amplified products were analyzed by restriction fragment length polymorphism.

Genotyping of SNP (His1058)

Genomic DNA was extracted from peripheral blood samples by standard procedures G. spin TM and then stored at (-20 °C) till use.

The fragment of interest was amplified by PCR, using primers.

The primer sequences used were:

F: 5'-ACCTGCCGAACTACAACTGG-3'

R: 5'-TGAAGGAACAGGCGGTTAGT-3'

PCR amplification was carried out in a total volume of (25 µl) containing (50 ng) of genomic DNA, (6.25 pmol) of each primer, (25 µl) short tandem repeat (STR), 10x buffer (STR 10x buffer, Promega, Madison, Wl, USA). The PCR was performed in a PTC-100 (convergys TCL) thermocycler as follows: initial denaturation at (95 °C) for (15 min), followed by (34 cycles) of denaturation at (95 °C) for (1 min), annealing at (55 °C) for (1 min), and final extension at (72 °C) for (1 min), with the final extension of (10 mins) at (72 °C)

Aliquots of the amplified PCR products of (317bp) was digested by restriction enzyme Pml1 at (37 °C) for (16 hours). A single (317bp) band indicates homozygosity for the CC genotype. Two

bands of (274bp and 43bp) indicates homozygosity for the TT genotype and combination of (317bp, 274bp and 43bp) bands indicates heterozygosity for the CT genotype. The recognition site was identified by ethidium bromide staining of fragments separated in a (2%) agarose gel.

Statistical analysis

Appropriate descriptive and analytical statistical procedure was followed using Statistic Package for Social Science (SPSS) version 26 on programmed computer. t-test applied to compare biochemical quantitative data between case and the control groups. Chi- square test was used to find the association between genotypes and biochemical variables. The level of significance was expressed as $P < 0.05$.

Results

Glucose, insulin hormone, and HOMA-IR parameters of women from PCOS and control groups were summarized in (Table I). There was statistically in-significant difference in glucose between the two groups, while BMI, LH/FSH ratio and insulin hormone were significantly higher in women with PCOS (P=0.000) when compared with non-PCOS. In the PCOS group, there was higher frequency of TT genotype. However; there was insignificant variation between two groups in genotypes frequency (Table 2). In PCOS women, there were insignificant differences in BMI, fertility hormones, glucose, insulin levels, and HOMA-IR based on His1058 genotypes, when compared with non-PCOS women (Table 3).

(Table 1): comparison between mean of age, BMI, plasma levels of LH, FSH, LH/FSH ratio, glucose, insulin and HOMA-IR in polycystic ovary syndrome group and non-polycystic ovary syndrome group.

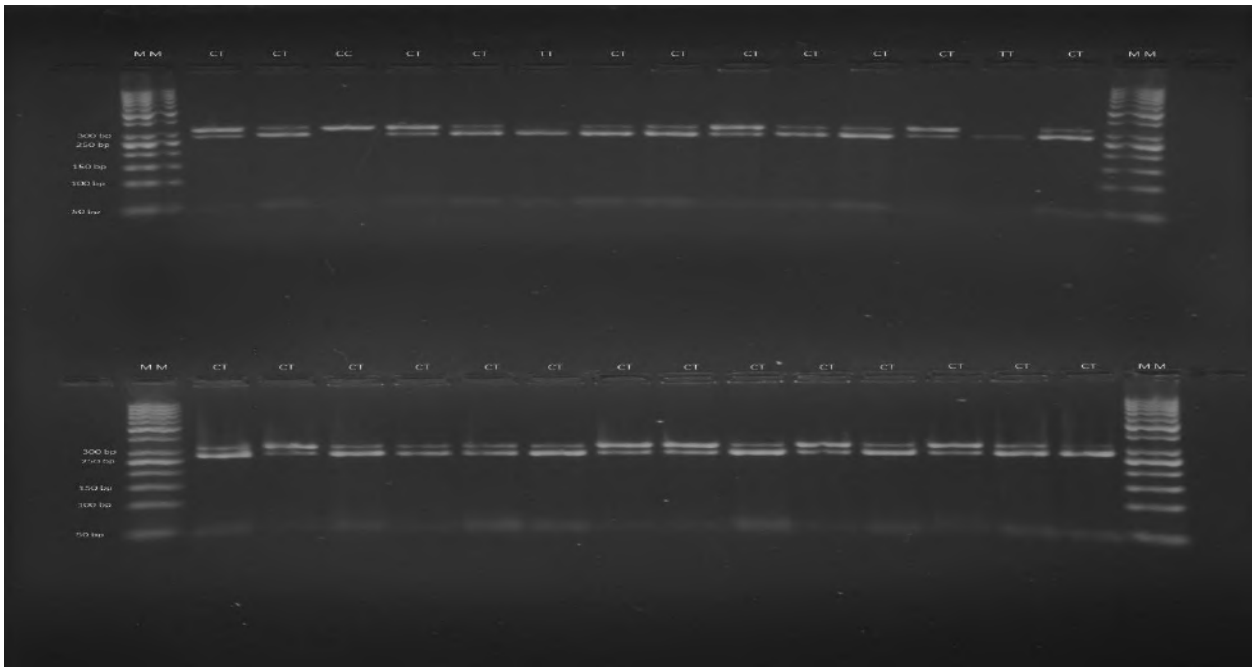
Variable	PCOS (Mean± SD)	Non PCOS (Mean ± SD)	P-value
Age/year	29.0± 6.0	28.5± 5.5	0.432
BMI kg/m^2	28.6±4.8	22.9±1.3	0.000
LH IU/l	10.5±6.2	4.4±1.4	0.000
FSHIu/L	6.6±2.9	8.2± 2.2	0.000
LH/FSH ratio	1.8±1.4	0.5±0.1	0.000
Glucose (mg/dl)	89.9±12.5	89.7±12.6	0.916
Insulin (µIU/ml)	4.48±3.60	0.71±0.72	0.000
HOMA-IR	0.981±.79	0.157±0.16	0.000

- Independent t- test was used to compare between the groups
- P- value considered significant at level ≤0.05

(Table 2): Genotypes frequencies of rs-1799817 in PCOS and control groups**.**

Genotyping	**PCOS** **No.= 144**	**Non-PCOS** **No. = 139**	**P- value**
CC(Normal)	2 (1.4%)†	2 (1.4%)	
CT(Hetero)	128 (88.9 %)	128 (92.1 %)	0.607
TT(Mutant)	14 (9.7%)	9 (6.5 %)	

- † Frequency and percentage of genotypes. P- value was obtain by Chi- square test.



(Figure I): Electrophoretic gel represent genotyping alleles of insulin receptor gene (SNP rs1799817) polymorphism TT (mutant), CT (hetero) and CC (wild) types.

(Table 3): Comparison between rs-1799817 genotypes and BMI, fertility hormones, insulin, FBG, and HOMA-IR

Variables	Genotypes			
	CC	CT	TT	P- value
BMI kg/m^2	28.1± 1.4	28.5± 4.8	29.2± 6.0	0.871
LH IU/L	12.5± 9.7	10.3± 6.2	11.2± 6.3	0.802
FSH IU/l	6.5± 6.3	6.7± 2.9	6.0± 3.1	0.657
LH/FSH ratio	1.9± 1.6	1.8± 1.4	2.2± 1.7	0.538
Glucose (mg/dL)	99.0± 4.2	90.1± 12.7	87.7± 12.7	0.491
Insulin (µIU/ml)	4.7± 4.8	4.6± 3.6	3.6± 3.7	0.597
HOMA-IR	1.1± 1.1	1.0± 0.7	0.7± 0.8	0.594

- One way ANOVA was used to compared between groups.

Discussion:

PCOS is the most common endocrinopathy among women in the reproductive age [11]. In this study, mean age of the studied patients was as 29.0 (6.0) years This is comparable to the study done by Krithika *et al*., where mean age of PCOS patients was 27 (7.1) years[12].

In this current study, serum LH, FSH levels and LH-FSH ratio were significantly increased in women with PCOS when compared with non PCOS. Disturbance in the pulsatile nature of gonadotrophin releasing hormone (GnRH) results in the relative increase in LH to FSH release[13]. An abnormal feedback mechanism by ovarian estrogen is blamed to play role in this discriminated increase in LH release[14]. As a result of this derangement, the ratio between FSH and LH levels which is normally around (2 to 1), become reversed and sometimes even more (2 or 3 to 1) in approximately (60%) of the patients with PCOS[15]

This current performed study revealed significant increase of insulin hormone, and HOMA-IR in women with PCOS compared to non-PCOS group (P-value= 0.000). This result similar to another result carried out by Shirazi and Jeddi, which showed that, a high incidence of insulin resistance in PCOS patients[16]. Another study showed that, all extreme insulin-resistance states are associated with PCOS. The compensatory hyperinsulinemia of insulin resistance is closely associated with the un- ovulation of PCOS[17].

In this present study, there was insignificant variation in His1058 (C/T) genotypes distribution among study groups (P- value >0.05). however; there was increased frequency of T allele in PCOS women. Other researchers' results were in line with the current study, Urbanek *et al.* [18], Tehrani *et al.*,[19]Bagheri *et al.*,[20] and Xu *et al.*,[21] on Han Chinese. Rasool *et al.*, on Kashmiri women which found no association of His1058 (rs1799817) polymorphism in the INSR gene, insulin resistance, and PCOS risk[22]. Kumar *et a*l found an increased frequency of INSR His1058H T allele in PCOS patients from China and India[23].Tucci et al. on Canadian population and Tucci *et al* on Caucasian population had found an association between rs1799817 and PCOS[24]. Siegel *et al* on Americans argued for the first time that the INSR gene itself took part in the development of insulin resistance as the main cause of PCOS[25]. This variation of findings may be due to different ethnicity.

This study had some limitations. As this was case control study, long term complications and sequel of PCOS could not be studied.

Conclusions: PCOS has varying clinical manifestation including endocrine manifestations, most commonly affecting the young women of reproductive age group and can lead to reproductive and metabolic complications in the long term. Majority of the patients present with elevated LH/ FSH ratio and some of them revealed mutant allelic variation. Also, the study revealed a high incidence of insulin resistance in PCOS patients, suggests that other polymorphisms of insulin His1058 (rs-1799817) may be associated with the pathogenesis of PCOS.

Conflicts of Interest: authors declare no conflicts of interest.

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Measures of community practice and behavior to control immature stages malaria vectors in Gedarif state, eastern Sudan

قياس ممارسات وسلوكيات المجتمع تجاة مكافحة الاطوار المائية لناقل الملاريا في ولاية القضارف ,شرق السودان

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ABSTRACT

We conducted study to determine the densityof malaria vector by A Knowledge Attitude and Practice study was conducted to identify potential behavior in community for mosquito control in sites selected randomly. The abundance of larvae increases in July to august the, abundance of adult increase during august to September and high cases of malaria disease observed in August to October. .d a lack of awareness of The study showe control due of poor education and homes constructed from localmaterials. Children and pregnant women most exposed to malaria, although mosquito nets distributed to families by health authorities and most of them use nets at Night. Eighty-nine percent (89%) of participants used nets in the fall, good use was observed in Hawata. More than two person infected with malaria (31%) during sex month ago in any family participated in study. Evaluation of insecticide resistance should be carried out regularly, health authority arises awareness for modification and manipulation environmental to reduce breeding site.

Keywords: Abundance s, Attitude, Evaluation, knowledge, Practice and survey.

المستلخص

تم اجراء مسح لتحديد كثافة الباعوض الناقل للملاريا لمعرفة العادات والممارسات والسلوك المحتمل في المجتمع المحلي تجاة مكافحة الباعوض في المواقع التي تم اختيارها عشوائيا . تزداد كثافة الاطوار المائية او اليرقات في الفترة من يوليو الي اغسطس وتزداد كثافة الاطوار البالغه في الفترة من اغسطس الي سبتمبر وترتفع حالات الاصابة بمرض الملاريا في الفترة من اغسطس الي اكتوبر . واظهرت الدراسة عدم الوعي بطرق السيطرة علي الناقل بسبب فقر التعليم وطبيعة المباني التي تساعد في ايواء الناقل . اظهرت الدراسة ان الاطفال والنساء الحوامل هم الاكثر عرضة للملاريا رغم توزيع الناموسيات بواسطة السلطات الصحية ويتم استخدامها ليلا فقط. اوضحت الدراسة ان 89% يستخدمون الناموسية في فصل الخريف ,تم ملاحظة الاستخدام الجيد في منطقة الحواتة . واوضحت الدراسة ان اكثر من شخصين (31%)من الاسر المشاركة اصيبو بالملاريا خلال ستة اشهر الماضية. يجب اجراء تقييم دوري للمبيدات بصورة مستمرة للتاكد من فعاليتها , رفع الوعي الصحي للسيطرة علي البيئة من تصريف المياه وردم البرك لتقليل مصادر التوالد .

كلمات مفتاحية :تقييم ,عادات, مسح , معرفة,ممارسات و كثافة .

INTRODUCTION

In 2017, an estimated 219 million cases of malaria occurred worldwide (95% confidence interval [CI]: 203–262 million), compared with 239 million cases in 2010 (95% CI:219–285 million) and 217 million cases in 2016 (95% CI: 200–259 million). [1].

The main groups of malaria vectors in Africa are *A.gambiae,A.funestus, A.nili and A.vmoucheti*. Each of these comprise a complex or group of genetically distinct species that are similar in morphology, but vary in traits that affect their role in transmission of malaria [2]. In Sub Saharan Africa, where 90% of the world malaria cases occur, *A. gambiae* Giles, *A. arabiensis* Patton of the *A. gambiae* complex and *A. funestus* Giles from the *A. funestus* group are the most efficient malaria vectors [3].

There are four main reasons for the failure of health education in malaria control. The first reason is the type of populations that suffer from endemic malaria in poor countries or in depressed areas with low educational standard and poor housing, hygiene and general environmental conditions. Accessibility to these populations is often difficult, and the medical facilities available to them are, to say the least, scarce... A second reason is that malaria is part of a socioeconomic depression complex. A third difficulty is the nature of the disease itself, specifically the complexity of its epidemiology ...The fourth reason for failure of health education in malaria control is the methods currently employed [4].

In Gedarif State, eastern Sudan, malaria cases arise after rainfall season. The prevalence of malaria in Gedarif state is 49,812 in (2012), 25,143cases in (2013) and 50,978cases in (2014). During the Malaria Indicator Survey (2016), Gedarif state was considered as moderate incidence between other states (5.4%), carried predominantly by A. *arabiensis* mosquitoes [5].

Malaria intervention in Gedarif state relies only on controlling the adult stage of the vector (IRS, LLINs and space spray). Major challenges to mosquito adultciding include the emergence of pyrethroid resistance for the primary malaria vectors in diverse areas of the African continent [6].

The Study objective are Measure malaria vectors abundance and breeding sites in 6 villages in Rahad area Gedarif state. Determine the impact of environmental management of immature stages of malaria vectors, through larvae source management. Identify role of human practices and behaviors that increase larvae source sites and their role in larval control.

Materials and Methods

Study Design

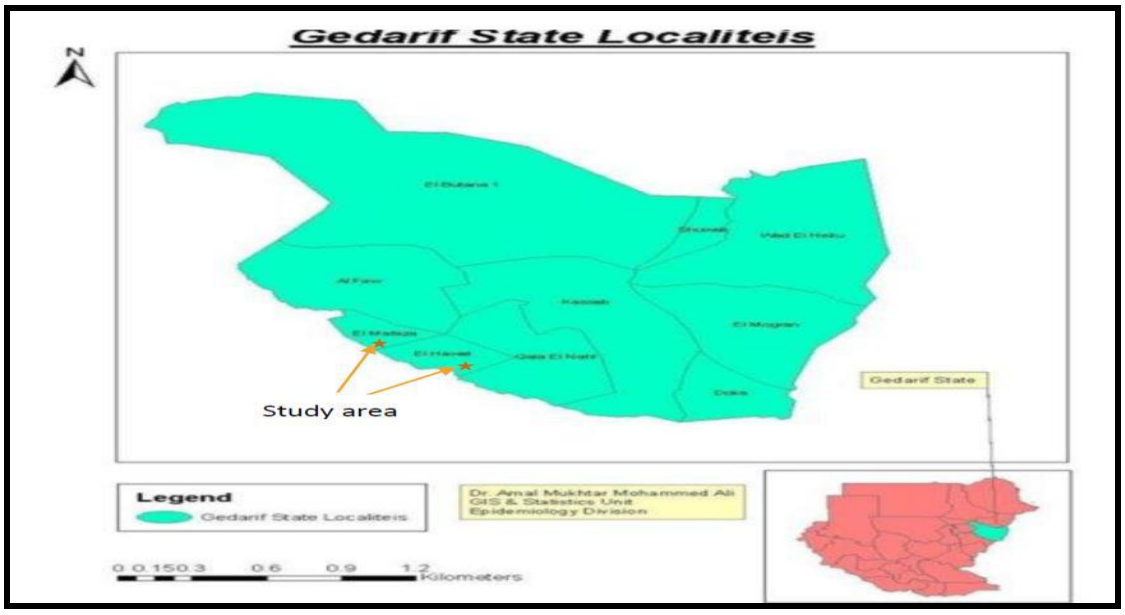
A cross sectional study was Conducted to determine the abundance of immature and adult stages of malaria vectors in study area and Conducted Knowledge, Attitude and Practice (KAP) study to identify potential behaviour in community for mosquito control through questionnaire.

The study was conducted in two localities**:** Mafaza locality (Mafaza, Abu Rakhm, Eltinadba, and Banat Sharg) and Rahad locality (Hawata, Ingas), Gedarif State. The Villages was selected randomly between all Mafaza and Rahad Villages in 2018 -2020.

Study area

Gedarif state is one of a most important states in the Sudan and play great role in economical and agricultural activities in the country. lies between latitude 14-16 north and 33-36 E longitude. It is a part of eastern region, border by Khartoum state in North, sinnar State in the South, Kassala State, Ethiopia in the East and Gezira State in the West. A population of state is estimated 1,827,181. Poor savannah, Clay and muddy soil, average of rainfall is 612 /ml. there are many mountains scattered through the State, many forests, there are many Rivers passes through the State (Atbra, Elrahad, Saitit and basalam)

Malaria transmission stared after rainy season during September to November cases rise, Plasmodium falciparum responsible for more than 90% of cases and the principal vectors involved in malaria transmission are *An. arabiensis* [7].



Map1, showed Gedarif localities

Sample size by:

$$n = \frac{N}{1 + N(e^2)}$$

n=sample size =population (households) e=level of precision

Materials required for study

Format of larvae and Adults collection and questionnaire to measure human practice and behavior

Larvae equipment

Dipper, larval net, large tray, pipette, specimen tubes (vials), alcohol solution (Ethanol 70%), cotton wool, a pencil, and safety match or lighter and a wide-mouthed vacuum bottle.

Adult equipment

Spray sheet: White cotton sheets (sizes 2m x 1m, 2m x 2m and 2m x 3m); hand sprayers; permethrins Iresol; small Petri dishes; paper cups; hand lens; forceps; a container (or preferably a picnic box) for transporting mosquitoes; cotton wool; filter paper; a torch **[8].**

Data collection: Data were collected by a team of four interviewer's public health officers, trained by the researcher for one day in how to fill the questionnaire according to the study objectives and methodology with practical and field training on data collection tools.

Data analysis: The collected data was interred to excel sheet software and analyzed using suitable inferential statistics in addition to descriptive statistic (mean, median, percentage).

Results

Pre survey to determine the abundance of immature and adult to undertaken to measure the abundance of malaria vectors adult, the number increase during august and September (Fig. 4.1, 4.2), breeding sites abundance of larvae increase in July to august (Fig 4.3 and 4.4) in study area.

The results of the present study reveal that high cases of malaria disease observed in August and October 2018 in the study site due to the rainy season presented in figure (4.5), the rain been stopped during August and start again in September that provide new source of breeding site larvae in study area.

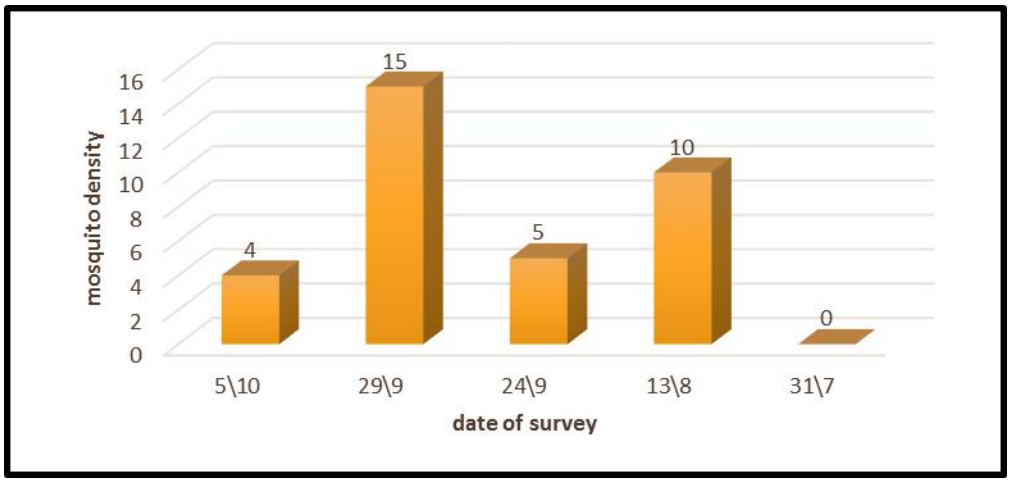


Fig (4.1) **mosquito collection of adult mosquito in Hawata, 2018**

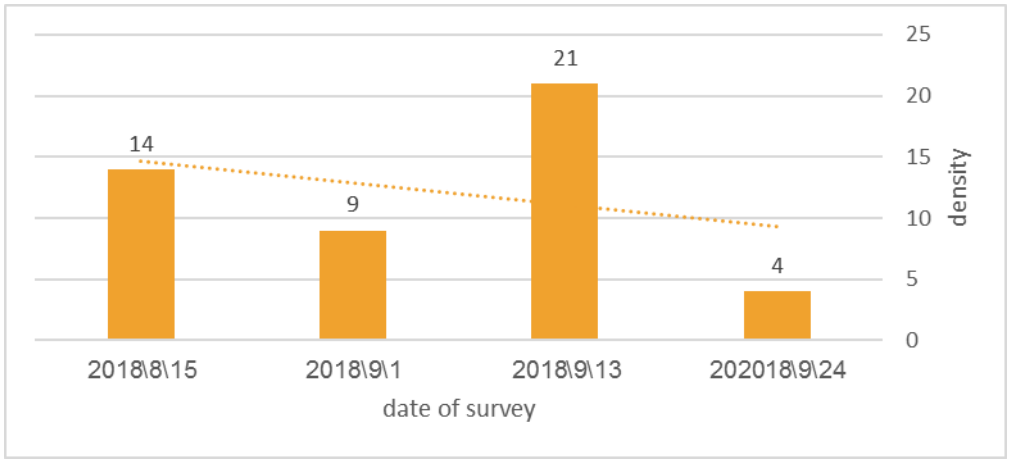


Fig (4.2) **adult mosquito collection in Mafaza city**

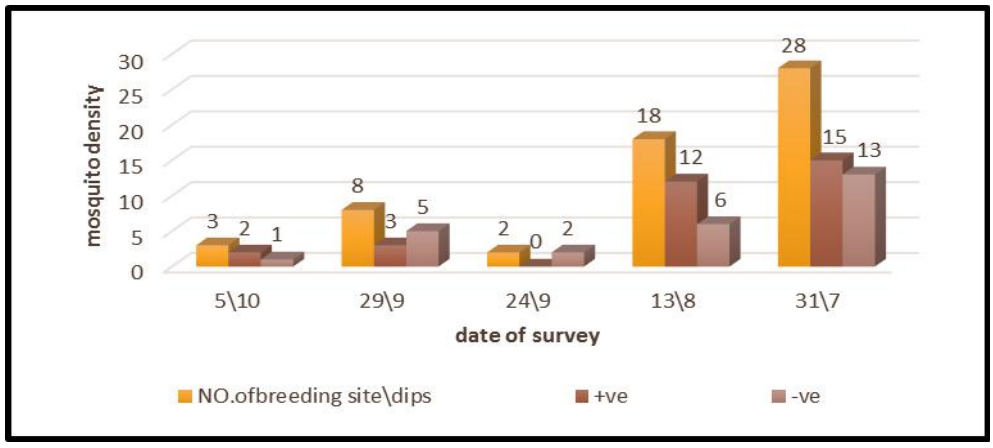


Fig (4.3) **mosquito larvae in Hawata city, 2018**.

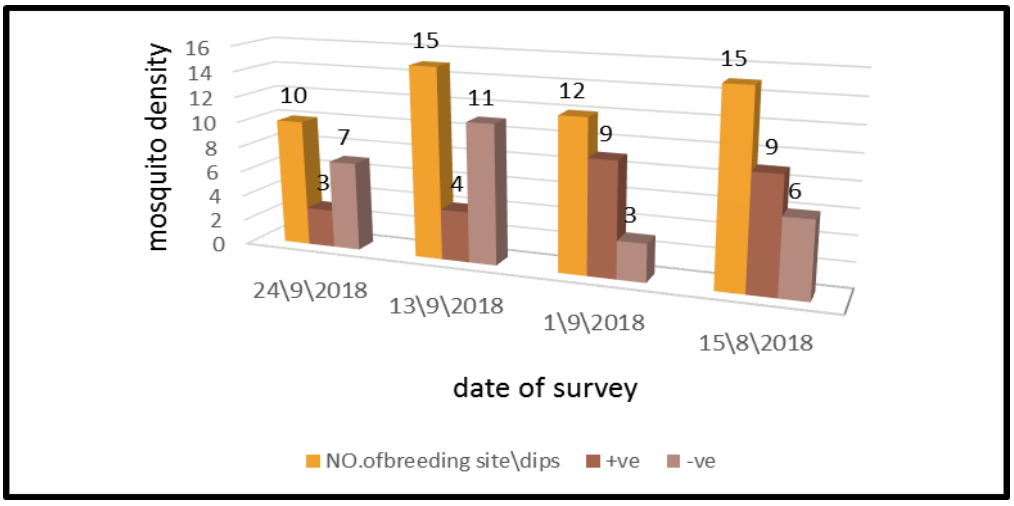


Fig (4.4) **Mosquito larvae collection in Mafaza city,2018.**

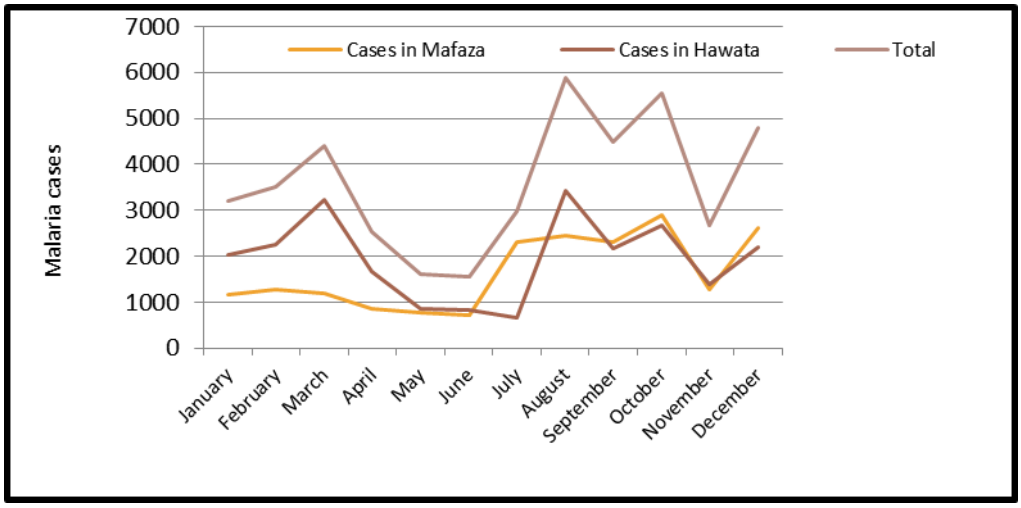


Fig (4.5) **high cases of malaria observed in Rahad and Mafaza localities August and October,2018**

The study results of community behaviour (Knowledge Attitude and Practice), presented in figure (4.6). Low income of the participant was observed in Aborakham (75%), Regarding the education in Alangas area a majority of the participants have khalwa education only (Fig. 4.7) however, most of families have more than three children under five in Altnidba. The results of the present study reveal that the majority of house (78%) build with local material

The results of the present study show that most of families were utilized LLINs and Know how to protect family member against mosquito bite (fig 4.8). The present study confirmed that most of the participant people believe malaria is a fatal disease, must protect themselves and families, 94% of the participants used mosquito net for night sleep. and 89% of participate utilize bed net in autumn season, good utilization observed in Hawata (Fig. 4.9), Participants families'

response that health authority explains and encourage member families how to prevent themselves from malaria by utilizing mosquito net, 38% Participants families' utilization LLINS in early rainy season and sources of LLINs they owned by health authority (Fig. 4.10). The results of the study showed that the most of vector breeding site is temporary site, 69% of larvae sources site is rainfalls water, the most of breeding site were ditch in Aborakham and majority of breeding site were puddles Altnidba, 17% of characteristic of breeding in clear water and 54% turbid water (Fig.4.11). More than 41% of family member infected with malaria during last six months, at least one person that showed in (Fig 4.12), in Altnidba 91% of cases were infected in autumn season, but in Hawata malaria cases occur during all season.

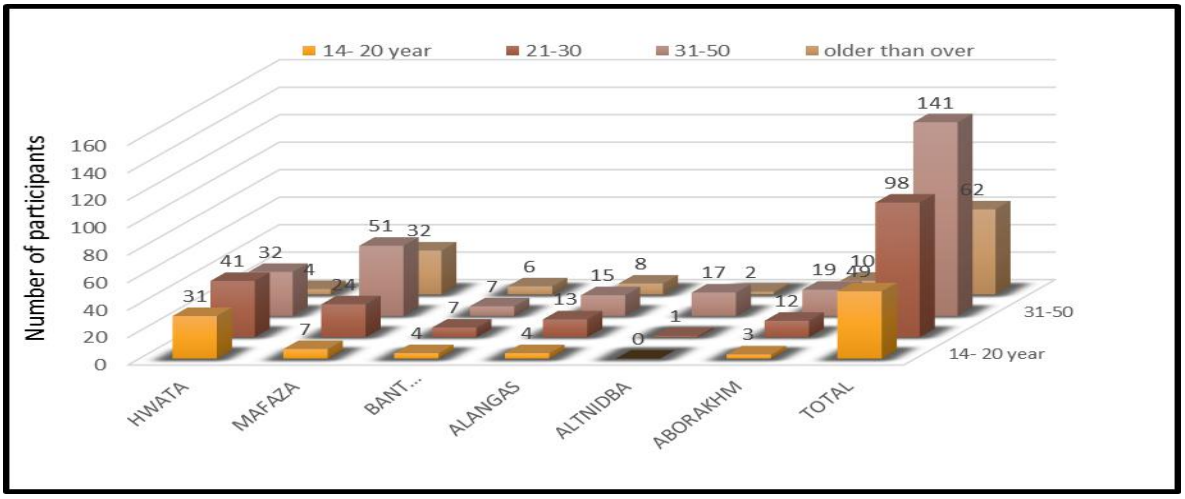


Fig. (4.6**) Age of participation in Rahad and Mafaza localities, Gedarif State**,2018.

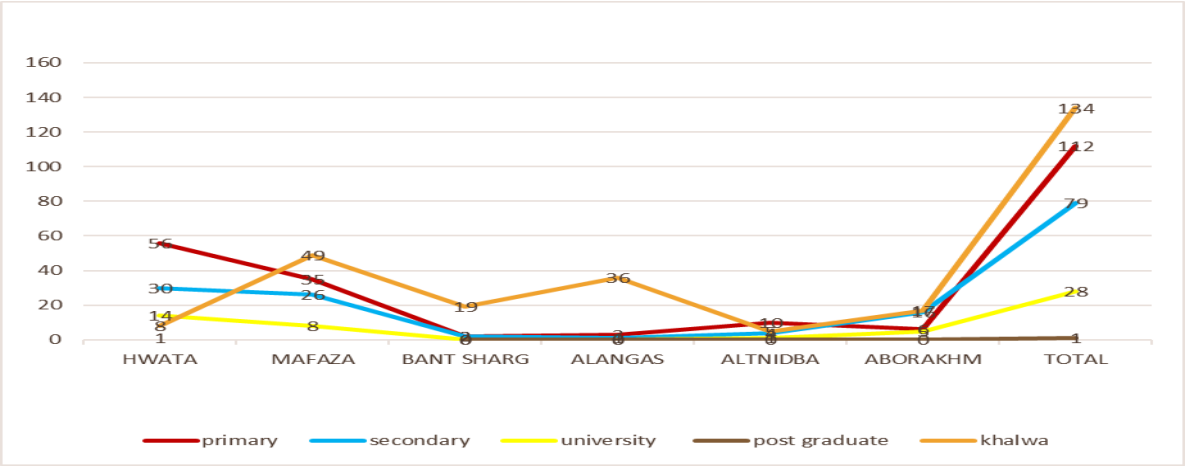


Fig. (4.7) Explain The education level in study, Rahad and Mafaza localities, Gedarif State

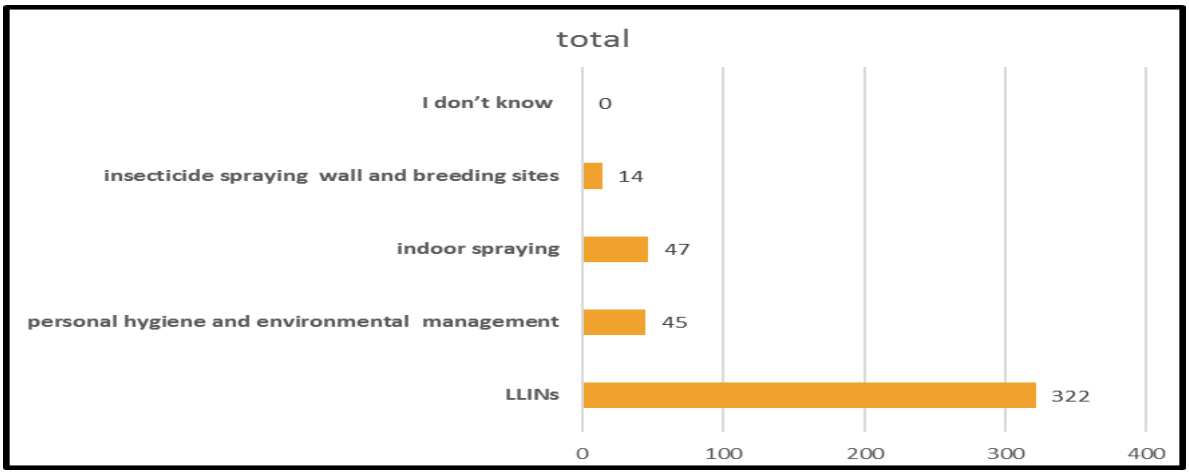


Fig. (4.8) Personal and family protection from mosquito bite, Rahad and Mafaza localities, Gedarif State

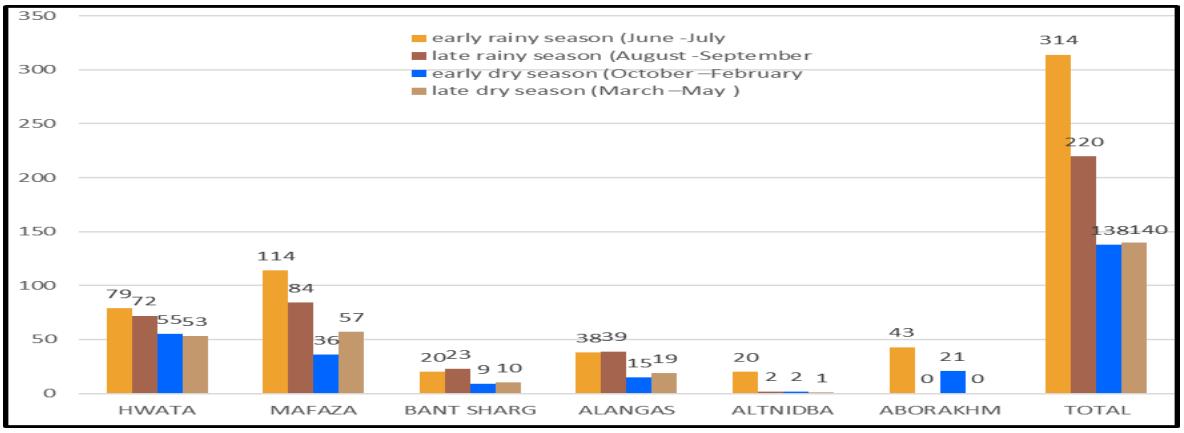


Fig. (4.9) Participant's response seasonal utilization of LLINS, Rahad and Mafaza localities, Gedarif State,

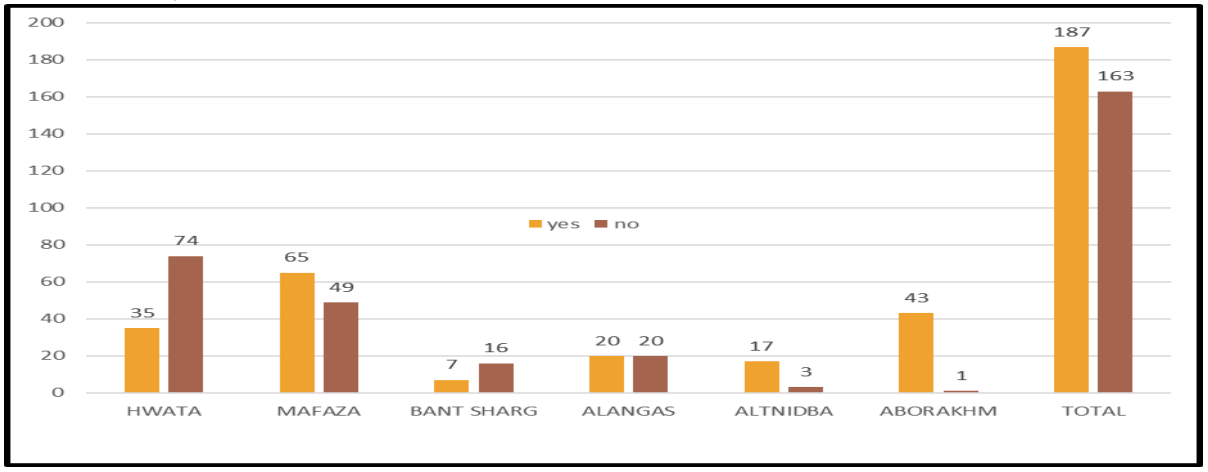


Fig. (4.10) Participants family's response that health authority explains and encourage member families how to prevent themselves from malaria by utilizing mosquito net, Rahad and Mafaza localities, Gedarif State.

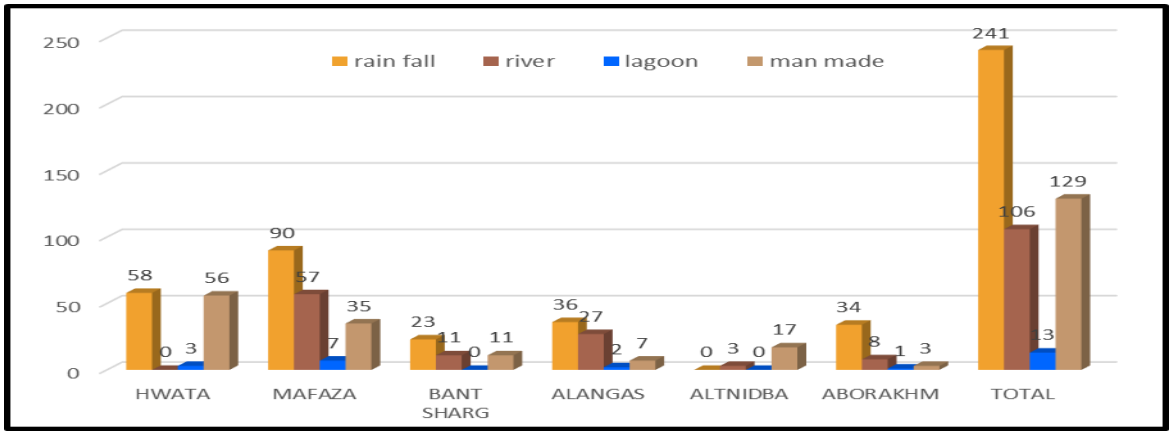


Fig. (4.11) Source of breeding site in Rahad and Mafaza localities, Gedarif State

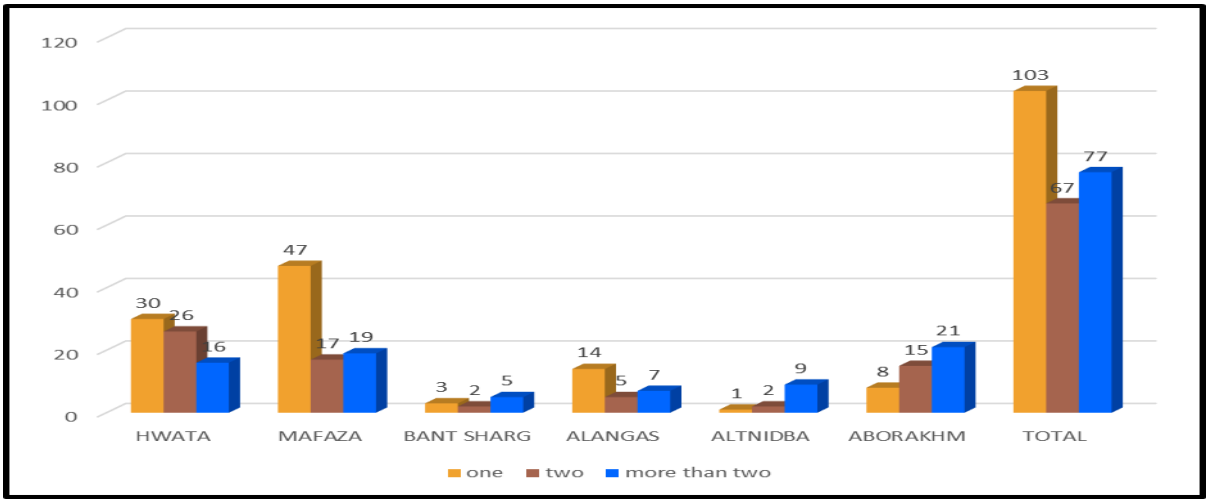


Fig. (4.12) Family member infected with malaria late six months of the year 2018 in Rahad and Mafaza localities, Gedarif State,

Discussion

The study result was observed a malaria vectors, adult abundance increase during august and September in Rahad area Gedarif state, breeding sites and abundance of larvae increase in July to august and high cases of malaria disease observed in August and October2018, the rainy season patterns separate during august and continue in September that led to new larvae source in study area in the season, that agree of malaria transmission depend on climatic condition that may affect the number and survival of mosquitos, such as rainy season patterns [9].

we conducted knowledge, Attitude and practice, that obtain the age of participation (40%) between 31-50 year and 50% of participate them female, the majority of people complete Khalwa education level, that lead to weakness in awareness of community for vector control knowledge and practice, that agree study conducted in Nyabondo, Western Kenya that obtain more than half (53.8%) reported to have attained primary education [10]. majority of house structure (78%) build with local material that corresponds conducted in bariango, kenya obtained poorly constructed house had higher malaria cases [11]. Most of families get LLINs by health authority. these similar to result in rural communities of Benue state, Nigeria [12]. Most of people believe the malaria it serious disease must be protecting yourself and family, these agree world malaria report obtain more than 229 million clinical cases of malaria occurred and 409000people died of malaria in2019 [13]. More than89% of participate utilize bed net in autumn season, good utilization observed in Hwata, that agree study conducted in same area it obtained the most of people (94%) used mosquito net for night sleep and 61% of the households used bed nets after sunset directly [14]. the most of breeding site in study area is temporary site and the majority (69%) of larvae sources site due to rainwater, that agree physical environmental factor such as temperature, humidity and rainfall were support the existence of anopheles' mosquito breeding place [15].

Malaria cases in participated families obtained more than two people were infected with malaria infectious (31%)during sex month ago, in Altnidba 91% of cases occurred in the last rainy season, but in Hawata malaria cases occur during all season. in Mafaza 78% of participate didn't know the causative factor of malaria disease, but in Aborakham 68%they realize the causative factor of malaria disease and 53% of participate realize the control method of malaria disease .in Mafaza and Banat (79%,63%) of participate used traditional fumigation method for control malaria vector; all over was agreed, malaria knowledge was poor and only 48%associated malaria with mosquito bite. other measure used by villagers to prevent mosquito bite were smoke and coils [16].

Conclusions

- The age of participation (40%) between 31-50 year and 50% of participation was female. the majority of people complete Khalwa education level, it leads to weakness in community for awareness vector control practice and knowledge.
- Most of families (71%) had one women in productive age and majority of house structure (78%) build with local material.

- Most of families get LLINs by health authority, more than89% of participate utilize bed net in autumn season.
- Most breeding site in study area is temporary site and the majority (69%) of larvae sources site as result of the rainwater.
- People infected with malaria (31%)during sex month ago, in Altnidba 91% of cases occurred in the rainy season, but in Hawata malaria cases occur during all season.

Recommendations

- A malaria vectors adult abundance increase during august and September, breeding sites increase in July to august in Rahad area Gedarif State, temephos should be used to reduce breeding sites.
- Intensive Health education to change the practice of utilizing LLINs in all season for protect against mosquito and other insects

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Factors affecting performance in clinical practice among undergraduate nursing students in governmental universities in Sudan 2021

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ABSTRACT:

Background Nursing Clinical practice is an important component of nursing education which is acquisition of knowledge, language, nursing skill, problem solving strategy. This study aimed to assess factors that influence clinical practice performance among bachelor's degree-level nursing students in seven governmental universities within Khartoum State, Sudan. **Design**: A quantitative cross-sectional approach was used in the study. The study was conducted at seven governmental universities in 2021 Sudan. A total of 300 nursing students were involved in the study ,selected randomly from all these nurses students.Data was organized and collected using a self-administered questionnaire. The data were analyzed using SPSS Version 25. **Results**: Most of the students (203, 67.7%) agreed that a student's behavior can be a barrier to clinical learning. The most selected reason for poor clinical practice was improper clinical supervision (93, 31.0%), followed by improper clinical supervision . The highly reported barriers include student factors such as lack of self-confidence (98,32.7%) and absenteeism (76, 25.3%). This study found a significant association between type of barrier and gender (p = .097).**Conclusion:** Students based factors which play important role in the performance in clinical area also hospital based factors lack of resources, quality of practical assessment in clinical area, and anxiety these factors obstruct the effective clinical learning.**Recommendation** an orientation to the hospital setting and implementing clinical simulation through high fidelity manikins that will ease the anxiety and offer good clinical practice to nursing students

Keywords: Factors affecting performance in clinical practice, undergraduate nursing students , governmental universities , Sudan

INTRODUCTION

Learning in clinical practice is an important component of nursing education, as nursing is a practice-based profession [1,2]The quality of nursing education largely depends on the clinical experience that nursing students receive in their supporting clinical environment [3,4,]. This clinical practice takes place in a complex dynamic social environment in which patient care and student learning are concurrently administered. A recent nursing education study reported that clinical experiences involve factors such as the application of theory to practice, effective mentoring, and constructive feedback associated with clinical practice aimed at enhancing positive learning and practice adaptation [5]However, poor relationships with clinical staff, a lack of support from nurse educators (NE), and a lack of challenging learning opportunities are some of the negative factors that can affect student nurse learning [6,7]. Challenging learning experiences are context based and hence differ from one clinical learning environment to another; they are common in most developing countries around the world, including Malawi [8,9,10]. Nursing education is a combination of both theoretical and practical learning experiences that enable nursing students to acquire the knowledge, skills, and attitudes for providing nursing care [11].Globally; the clinical training of nursing students is seen as the basis of nursing practice. Nursing students need to be supported and guided so that they can become responsible, accountable, and independent professionals who are able to function within the scope of professional practice [12].Clinical practice provides an opportunity for students to apply theoretical knowledge to actual health care provision [13]. Clinical placements enable nursing students to gain essential skills and provide safe and quality nursing care through real-life practice [14, 15].In the course of clinical practice, students apply their theoretical knowledge in a real environment, develop psychomotor skills, and observe and adapt to their professional roles. The clinical environment should be carefully selected, accepted by nurse tutors, and prearranged to be capable of transforming nursing students into competent nursing practitioners [16]; this is dependent on factors such as curriculum design, cost effectiveness, and relationships with specific health facilities [17]. The environment where nurses learn clinical practice, especially in Sudan and similar settings, is challenged by a multitude of factors that can affect learning diversely. The factors reported to affect student learning in clinical training can be categorized into different levels: individual, nurse tutor, hospital environment, and social-economic factors [18]. A study conducted in Botswana revealed that nursing students failed to apply theory into

practice because they lacked adequate supervision in the clinical area, which resulted in low performance in their clinical practices [4].It has been reported that clinical instructors' attitudes affect the performance of nursing students in the clinical area. Positive attitudes and a supportive environment encourage students' learning. Constructive criticism improves practice in a clinical setting, while negative criticism is an obstacle to effective clinical performance. A limited chance with on-hand hospitals, shortage of nurse tutors and clinical instructors, and too many students in a program can negatively affect the performance of students in clinical practice [19].

The students' behaviors can negatively affect their performance in clinical practice, such as an inability to demonstrate knowledge and skills, attitude problems, unprofessional behavior, poor communication skills with patients and clinical instructors, not asking questions, overconfidence, unmotivated to learn or to work, lack of confidence, and dishonesty [20]. A lack of prior clinical experience, unfamiliar areas, difficult patients, fear of making mistakes, and being evaluated by faculty members have been expressed by students as anxiety-producing situations in their initial clinical experience [21].The initial clinical experience was found to be the most anxiety-producing part of their nursing education. The sources of stress during clinical practice have been observed by many researchers and include a new environment, lack of assessment before supervision, poor clinical orientation, and shortage of nurses [22,23].Stress or anxiety is not only a workplace problem, as different stressors can also affect student learning [24].

There is an increased call for improving the environment in which nursing students learn clinical skills, especially in settings with poor or limited resources. Placements where students learn clinical practice should allow students to acquire nursing skills and clinical reasoning and develop as professional nurses. In areas where simulation learning is limited or not available at all, learning must take place in a real environment. Therefore, this study aimed to determine what factors affect performance in clinical practice among bachelor's nursing students. Specifically, it sought (1) to measure factors that affect nursing student's clinical performance and (2) to assess factors that contribute to improvement in clinical practice. This was done by determining the associations between the measured variables. Finally, the results were placed in context with regard to policy, education and practice.

MATERIALS AND METHODS

The current study used quantitative cross-sectional community based studydone to assess Factors affecting performance in clinical practice among undergraduate nursing students in

governmental universities in Sudan 2021.

Study done in Khartoum state in nursing faculties seven governmental universities in Khartoum state.Sudan (Khartoum university,Omdurman Islamic university, Elneelain University, Bahri University, ElzaeemElazhari University, Health Science Academy, Sudan Technology University.

Study population: Population are undergraduate nursing students in governmental universities in Sudan 2021.

Data was collected from nursing faculties in seven governmental universities in Sudan, selected randomly. A total of 300 bachelor's degree-level nursing program students were part of the sample in this study. The number of students per school ranged from 600 to 720. To be in the sample, the participants had to be undergraduate students in a nursing program, second to fifth level, and had to agree to participate in the study. Those who had received a diploma from a nursing program or who did not wish to participate in the study were excluded. ***Data Collection Tools***: Firstly, we shared the tool with other researchers to give their expert opinion concerning its clarity, relativity, and significance. Secondly, a pilot study was performed by selecting a limited number of nurses students (n = 30) who shared their views on simplifying and shortening the questionnaire.nurses students from all universities settings were chosen for the pilot study. Participant amendments were considered and mended into the survey, thus maintaining continuity with the contemporary literature. After a thorough discussion, the authors finalized the questionnaire and dispensed it to the participants.The researchers developed a self-administeredquestionnaire based on Gemuhay(2019), which was modified to suit our culture. The questionnaire collected information on socio-demographic characteristics and factors influencing clinical practice categorized as student, hospital-based, and social-economic factors.

Data analysis: The questionnaires were numbered and coded. Information was collected on socio-demographic characteristics, factors that influence clinical practice, nurse tutor factors, and their opinions. A descriptive analysis was performed to summarize the participant information. This was presented in tables as frequencies and percentages. Means and chi-square tests were used to examine the associations between the variables. This analysis was performed using SPSS Version 25. A *p*-value of 0.05 or less was considered significant.

Ethical consideration: The purpose of the research was explained to the students, and verbal consent was obtained from each participant. Ethical approval was obtained from the Ethics Committee of Omdurman Islamic University, Omdurman, Sudan.

RESULTS

A total of 300 nursing students from seven universities completed the questionnaire. As shown in Table 1, there were 137 (45.7%) males in the sample and 163 (54.3%) females. Slightly more than half of the sample (174, 58.0%) was above 20 years of age.

Most students were from Khartoum University (63, 21.0%) and Omdurman Islamic University (63, 21.0%). The other universities that were highly represented were Elneelain University (50, 16.7%), Bahri University (49, 16.3%), and ElzaeemElazhari University (31, 10.3%). The smallest number came from the Health Science Academy (25, 8.3%) and Sudan Technology University (19, 6.3%).

Table 1. Socio-demographic data (n = 300)

Variable	Frequency	Percent (%)
Age		
17–20 years	126	42.0
Above 20 years	174	58.0
Gender		
Male	137	45.7
Female	163	54.3
University		
Khartoum University	63	21.0
Omdurman Islamic University	63	21.0
Elneelain University	50	16.7
Bahri University	49	16.3
ElzaeemElazhari University	31	10.3
Health Science Academy	25	8.3
Sudan Technology University	19	6.3
Education Level		
Second year	22	7.3
Third year	152	50.7

Variable	Frequency	Percent (%)
Fourth year	89	29.7
Fifth year	37	12.3
Second year	22	7.3
Training Hospital		
Khartoum Teaching Hospital	67	22.3
ENT	96	32.0
Pediatric Hospital	73	24.3
Omdurman Hospital	16	5.3
Bahri Hospital	24	8.0
Elnaw Hospital	24	8.0

Table 2.Factors that contribute to improvement in clinical practice (n = 300)

Factors contribute to improvement in clinical practice	Frequency	Percent (%)
Effective supervision and assessment	56	18.7
Provision of quality care to patients	67	22.3
Self-engagement in clinical practice	75	25.0
Competency gaining in clinical areas	59	19.7
Demand to score high marks in clinical practice	43	14.3
Barriers to Good Performance in Clinical Practice		
Yes	203	67.7
No	97	32.3
Reasons for Poor Clinical Practice		
Lack of communication between staff and students	73	24.3
Improper clinical supervision	93	31.0
Clinical instructors are not well prepared for the task	75	25.0
Difficulties in orientation or clinical teaching	59	19.7
Student's Behavior Can Be Barrier to Clinical Learning		
Yes	175	58.3
No	125	41.7

Student's Behaviors Affect Clinical Practice		
Lack of self-confidence	98	32.7
Absenteeism from clinical area from time to time	76	25.3
Unsafe practice	58	19.3
Overconfidence	68	22.7

Table (2) above

shows the factors that contribute to improvement in clinical practice. Self-engagement in clinical practice (75, 25.0%) was the most selected factor. Most of the nursing students (203, 67.7%) agreed that a student's behavior can be a barrier to clinical learning. The most selected reason for poor clinical practice was improper clinical supervision (93, 31.0%), followed by improper clinical supervision (93, 31.0%). The highly reported barriers include student factors such as lack of self-confidence (98, 32.7%) and absenteeism (76, 25.3%).

Table 3. Reasons why clinical placement does not provide an opportunity for learning (n = 300)

Response of Participant	Frequency	Percent (%)
Shortage of nurse tutors or someone else as a guide in the clinical area	132	44.0
Inadequate learning resources	94	31.3
Inadequate supervision	74	24.7

As shown in Table 3, nearly half of the respondents (132, 44%) reported that clinical placement did not provide them adequate opportunity for effective clinical learning with a shortage of nurse tutors or someone else as a guide in the clinical area as the main reason.

Table 4. Causes and measures to reduce anxiety by nursing students (n = 300)

Response of Participant	Frequency	Percent (%)
Intrinsic Causes of Anxiety in Clinical Areas		
Fear of making mistakes	117	39.0
Lack of competency	71	23.7
Lack of experience	68	22.7

Fear of clinical environment	44	14.7
Situations that Cause Anxiety in the Clinical Area		
Clinical assessment during examination	88	29.3
Strict supervision	70	23.3
Death of patient	77	25.7
Practicing in intensive care unit	65	21.7
Measures to reduce anxiety		
Appropriate clinical supervision	105	35.0
Assignment and clinical case presentation	70	23.3
Proper placement in clinical area	69	23.0
Effective class room teaching	56	18.7

As shown in Table 4, most participants selected clinical assessment (88, 29.3%) during examinations as a situation that caused anxiety in the clinical area. Fear of making mistakes (117, 39.0%) was the most selected intrinsic cause of anxiety in the clinical areas. Appropriate clinical supervision (105, 35.0%) was the most selected measure to reduce anxiety, followed by assignment and clinical case presentation (70, 23.3%).

Table 5. Correlations between demographic data and barriers of performance in the clinical area

Variable	**Mean**	**SD**	***p*-value**
Age	1.5433	.49438	-.090
Gender	1.5800	.49895	
Barriers of performance in clinical areas	1.3233	.46853	.097

Table 5 shows the Correlations between some of participants' demographic data and barriers of performance in the clinical area. This study found a significant association between type of barrier and gender (p = .097).

DISCUSSION

This study aimed to assess the factors that affect clinical practice among undergraduate nursing students in governmental universities in Sudan. We found that there are several existing factors and barriers to effective performance in clinical practice, which are effective supervision, an adequate number of tutors and clinical instructors, self-engagement in clinical practice and the provision of quality care to patients. The barriers to effective clinical practice included a lack of self-confidence, absenteeism, inadequate supervision, lack of resources, and anxiety. The finding regarding effective supervision as a facilitator of effective clinical practice has also been reported by previous studies [25, 2, 26]reported that effective clinical practice promoted learning and helped students to achieve learning outcomes and competencies.

An ideal number of tutors and clinical instructors for the students would facilitate effective supportive supervision and improve the learning outcomes. However, in some situations, such as poor or limited resource settings, there is often a crisis of human resources for health, both in terms of numbers and motivation. Many barriers to effective clinical practice, such as a lack of self-confidence, absenteeism, inadequate supervision, lack of resources, and anxiety, have been shown in the study of [27]their results indicated absenteeism from duty led to poor performance in clinical practice, whereas our self-report study showed a lack of self-confidence as a contributor. A lack of basic equipment and supplies for nursing care procedures can make students ignore clinical practice. However, the students felt that clinical practice provides better opportunities and favorable settings to apply theory to practice [2].

In our results, we found anxiety over clinical assessment during examination reported by nearly one-third of the students (29.3%) as the factor that most affected them in their clinical performance. This finding was in line with a study conducted in Johannesburg, South Africa, which also found that anxiety contributed to poor clinical practice [28].Another situation that causes anxiety for students is the fear of making mistakes, which was selected by 39.0% of our sample; this was also similar to the findings of the South African study [28].The current study suggests that good supervision and providing assignments to students and presentations of clinical cases are factors that could reduce anxiety and hence lead to good learning outcomes.

In clinical settings, a shortage of staff, lack of learning materials, and overcrowding of patients do not provide opportunities for students to achieve their learning objectives and represent barriers to clinical practice. This finding is similar to a study done in Northern Tanzania [23]The

current study shows that many factors affect performance (positively and negatively) in clinical practice among undergraduate nursing students. These include student-based factors, which play an important role in the performance in clinical area (such as anxiety), and hospital-based factors, such as a lack of resources and quality of practical assessment in the clinical area; these factors can obstruct the effectiveness of clinical learning.

CONCLUSIONS&RECOMMENDATION

Clinical competencies of the instructor and attitudes of staff toward students in the clinical area can have an impact on performance in clinical practice. From the current results, one can suggest that there must be an orientation to the hospital setting and implementing clinical simulation through high fidelity manikins that will ease the anxiety and offer good clinical practice to nursing students.

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Conflict of interest

The authors of this article declare no conflict of interest.

Institutional review board statement:

The study was conducted according to the guidelines of the Declaration of Helsinki. The research was approved by the ethical committee of the Faculty of Nursing at Sudan University.

Informed consent statement: Informed consent was obtained from all study participants involved in the study.

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Effect of Housing System and Season on Egg Quality in laying hens in Khartoum state

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ABSTRACT:

This study was conducted to assess the effect of housing system and season on egg quality in Khartoum Stateduring the period of January – August.Towgroceries were selected randomly from each of the 3 localities. One egg tray from closed and one from open housing system were randomly selected from each grocery twice per month for six months. Five eggs were selected randomly from each tray for egg quality investigation, using the cluster method. The collected data divided into 3 seasons to study housing and season effects. Study showed significant effect of housing on (Egg Weight) ($P < 0.1$) , (Yolk Color) ($P < 0.01$) and (NS) on (Egg Shape), (Shell Thickness), (Yolk Index) and (Haugh Unit). Season showed significant effect on (Egg Weight), (Egg Shape), (Shell Thickness) and (Hough Unit) each at ($P<0.01$) and (Yolk Color) at ($P<0.05$). Wet season showed numerically the highest level over winter and dry summer for all parameters studied. Closed housing system also showed the better results for all parameters studied over the opened system.

Keywords: Housing, Season, Marketing Channel, Egg quality

INTRODUCTION:

Many genetic and environmental factors affect egg quality where housing system and season are ones on which few limited studies have been conducted. Alternative systems have become more important and the effect of these systems on egg quality parameters need to be determined **[1].**However there are limited studies evaluating differences among housing systems for egg quality traits across a production cycle **[2], [3].**As early as 1936 lorenz and Almquist noted seasonal variations of egg quality being better in winter and spring than in summer showing highest internal quality. Shell thickness was significantly lower in summer and specific gravity was significantly higher in young birds and during the cool season. Age and season significantly

affected shell weight and percentage and that during spring and summer months both shell weight and percentage decreased**[4].**

Indicated that high temperature limited the productive performance irrespective of kept intensively or extensively and that climate is one of the primary factors that affect egg production and quality**[5].**Confirmed that feed intake and feed gain ratio were lower in birds on 34 ˚C than on 21 ˚C irrespective of the breed or strain of chicken[6]. A study ofegg quality of different chicken genotypes in summer and winter found egg quality traits of egg color, yolk width and weight, albumen dry matter weight tended to increase in winter than summer. Eggs contained significantly high albumen dry matter weight; tend to increase in winter than summer. Eggs contained significantly high albumen width and height, yolk, egg shell weight and thickness, dry matter weight and yolk percentage in winter than summer. High temperature decreased yolk albumen and shell weight, shell thickness and specific gravity but increased HaughUnit (HU) rating**[7].** A study ofeffect of age and season on egg quality traits in Nigeria concluded that egg quality trait were better during early wet summer which favored the measured variables**[8-9].**A study found that eggshell abnormalities due to mycoplasma synovia appeared to be more in summer than other seasons with no effect on egg internal quality**[10].**A study on the effect of summer and winter season on egg abnormalities found significant differences due to season being higher in summer thanwinter though classified as minor abnormalities**[11].**Stated that season. Hen breed flock age and flock diseases, vaccination status interact to affect egg safety and quality in addition to housing system. They added that understanding of these different effects is prudent before any large scale move to an alternative housing system is undertaken.Funding for research into various housing programs and their effects on egg safetyquality only recently, has been made available in the European Union**[12].** Studying effect of open and closed system on egg production and quality found significant reduction in feed intake, egg production, shell thickness and (HU) inlayers reared in open than closed house and with increasing time egg production and egg weight increased in both housing systems**[13]. [14].**Compared initial quality of egg and hens of the same strain under intensive andextensive systems of management over 12 month period and found that change of quality due to maturing of pullet were small compared with seasonal effects as different measures of quality were differently affected by season in favor of cool months**[15].**

on the impact of different housing systems and age of layers on egg quality characteristics found highest egg weight, yolk weight albumen weight, shell weight, albumen index, yolk index Haugh Unit, shape index were all significant ($P < 0.001$) in conventional and enriched cages .They concluded that eggs on free range system were better in overall quality than eggs from both cage systems**[16].**Concluded that there was no general consensus demonstrating superiorityof one housing system over another regarding food safety and egg quality as many factors interact to affect egg quality**[12].**

This study was designed and conducted to investigate in variations ofegg quality throughout the year concentrating on housing system and season of the year and theirinteraction

MATERIALS AND METHODS:

To study effect of housing system and season on egg quality 2 groceries were selected randomly from each of the three localities of Khartoum State on each of day one and day 15 of every month for the six months of the study. From each grocery one tray was from open and one from a closed housing source as identified by the grocery owner. From each of these trays five eggs were randomly selected using the number method. These eggs were used for the quality study. All the data of the six month was used collectively for studying the housing effect.

The same data and months were arranged into 3 seasons January- Februaryas winter, April –May dry summer, and July – August as wet summer.Statistically the sampling followed the cluster method in a (CRBD) Complete Randomized Block Design and analyzed by ANOVAusingSPSS Version (16).

Parameters studied were:

- Egg weight (EW) in grams (g) using a 0.1 decimal sensitive balance.
- Shell thickness (ST) using a micrometer.
- Egg shape (ES) by the formula $\frac{\text{Egg Width}}{\text{Egg Length}} \text{ X } 100$
- Hough Unit (HU) using a slide Rule (Kaw Company).
- Yolk Index (YI) by the formula $\frac{\text{Yolk Height (Millimeter mm)}}{\text{Yolk Width Diameter}} \text{ X } 100$
- Yolk Color (YC) by Color Fan 1 -15 degrees by Roch Company, DSM.

In Sudanreports showed that the average temperature for the winter months range between 16 to 33 ˚C, for dry summer between 23 to 42 ˚C and for the wet summer 25 to 38 ˚C with an average of 31˚C[17].

RESULTS:

Table (1): Effect of open housing system on egg quality:

Parameter / Month	Egg weight (g)	Egg Shape %	Egg shell thickness (mm)	Yolk Index	Haugh Unit(HU)	Yolk Color
January	44.6	76.2	o.32	o.33	75.96	5.52
February	47.4	75.2	o.31	o.33	70.60	6.56
April	40.68	74.7	o.31	o.33	71.80	5.20
May	56.68	75.9	o.31	o.31	71.60	5.68
July	51.20	76.4	o.31	o.33	71.40	6.12
August	49.40	76	o.32	o.32	74.40	5.76
Total Average	51.29	75.74	o.32	o.33	73.08	5.51

Yolk color: YolkcolorFan - DSM

Hu: EggQuality Slide Rule - USDA

Table (2): Effect of closed housing system on egg quality:

Parameter / Month	Egg weight (g)	Egg Shape %	Egg shell thickness (mm)	Yolk Index	Haugh Unit(HU)	Yolk Colour
January	57.80	75.4	o.32	o.31	75.76	6.48
February	55.71	75.1	o.33	o.33	72.89	6.56
April	56.16	74.1	o.31	o.32	76.80	5.20
May	60.20	73.6	o.34	o.33	79.OO	7.12
July	59.20	74.9	o.34	o.35	73.92	5.08
August	56.16	74	o.35	o.33	76.64	6.80
Total Average	57.75	74.52	o.33	o.33	72.42	6.49

Yolk color: Yolkcolor Fan - DSM

Hu: Egg Quality Slide Rule - USDA

Table (3): Statistical Analysis of the effect of housing system and season on some egg quality Parameters:

Factors Housing System	weight (g)	Egg Shape Egg %	Egg shell thickness (mm)	Yolk Index	Haugh Unit (Hu)	Yolk Color
Open	51.29	75.74	32.16	o.33	72.42	5.51
Close	57.75	74.52	32.62	o.33	73.08	6.49
SE	0.541	0.772	0.118	0.382	0.13	0.217
Significance	**	NS	NS	NS	NS	**
Season						
Winter	53.15^{b}	71.10^{c}	32.69^{b}	o.34	72.79^{b}	5.74^{b}
Dry Summer	53.50^{b}	73.02^{b}	31.25^{c}	o.33	71.49^{c}	5.14^{ab}
Wet Summer	56.91^{a}	79.09^{a}	33.28^{a}	o.33	73.97^{a}	6.08
SE	0.663	0.776	0.144	0.468	0.16	0.266
Significance	**	**	**	NS	**	*
System X Season						
SE	0.937	0.976	0.204	0.662	0.226	0.376
Significance	**	NS	*	NS	NS	NS

N= 30

***=** significantdifferences at P < 0.05, **= significant differences P<0.01, NS = No significantdifferences.

Different Superscript letters within the same row mean significant differences at P < 0.05

DISCUSSION:

The study of the impact of different housing systems on egg safety and quality.

Stated that many factors act and interact to affect egg quality**[12].** This statement can be supported by some studies including seasonal and chicken maturity egg effect.Study ofchicken genotype and season**[15]**and**[7].**Also study of breed, strain, age and season in derived savanna zone of Nigeria**[6]**and**[9].**Other study of housing and age and in this study housing and season**[16].**

On the effect of housing the overall result of this study showed significant effect on egg weight and yolk color at (P< 0.01) but all the numerical figures for the closed system were better than the open forall parameters studied .Possible explanation could be attributed to better bioclimatic control that meets the bird biological needs and by better energy utilization. Results agreed with studies in Iraq and Nigeria in which found decrease in shell thickness and HaughUnit (HU) in open houses**[14]**and **[9].**And with similarto that found better egg weight for closed than open houses for all months studied**[15].**

On the effect of season on egg quality many workers stated that best egg quality was obtained in the cool months of spring and winter **[12]** and [4]. In this study the best quality parameters were obtained in wet summer which agrees with the finding in Nigeria**[9].**Thisfinding indicates temperature humidity effect an area that needs more in depth study.Shell thickness yolk index and HU showed the lowest numerical values in the dry summer which agrees with**[4], [15],[7]** and**[9].**This indicates temperature effect as was noted by **[18]**and **[19].**

Season effect showed high significance for egg weight, shape, shell thickness, HU at (P< 0.01).Yolk color at (p<0.05) and no significance for yolk index. Wet summer showed the best numerical values for all parameters studied.

Housing system X season interaction showed high significance for egg weight (P< 0.01) andshell thickness at (P< 0.05) supporting the move to closed housing system (for the open).

Comparing the numerical data with other findings and standards the study findings showed that the average egg weight for all months and seasons was 57.75g which is placed an medium size and was 51.29g for the open system which lies in the small size according to the below references.

In African countries 65+ g is considered large size 55 -65 g. as medium and 45 -55 g as small**[20]**.In Sudan 60-64 g is considered as large 55 – 59 g. as medium, 50-54 g. as under

average and 40 g as small size**[21]**.. This same reference puts HU at 72 units for high quality eggs and for first class fresh egg at 60-71 units meanwhile another study puts acceptable HU at more than75**[22]**.

In study HU ranged between 71 – 76 units for open system and 72-79 for the closed. For egg shape the figure ranged between 74-75 for the closed and 74-76% for the open system with no significant difference. Most references stated that 74 % is the acceptable number for the proper oval egg shape **[23].**The same reference puts yolk index at 0.42-0.49 and shell thickness at 0.31 mm.

In the study yolk index ranged between 0.31-0.32 mm for the open system and 0.31 – 0.35 for the closed indicating possible storage and time -duration - effect in the groceries studied. Shell thickness was better in the closed than the open system. yolk color using(Color Fan DSM) divided in to 1-15 degree was found at the range of 5.2- 6.6 for the open house and 5.2 – 7.1 for the closed system indicating pale yellow color for both systems though better for the closed system .This could be attributed to deficiency of yolk color pigments as a nutritional problem in both housing systems and seasons. Color preference varies with individual customers and various countries. New Island puts color preference at 13 degree**[24]**.

CONCLUSION:

The study concludes that both housing system and season have direct effect on egg quality. The study recommends more drive to the closed system for better egg quality specially egg size. Asat present more than 80 % of table eggs marketed in the Sudan come from the open unit farming system. This is in addition to that the international trend is marketing eggs by quality and not just by quantity as is practiced now in the Sudan which strengthens the move to better egg quality production.

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ملاحظات قصيرة

استخدام نموذج انحدار كوكس لمعرفة العوامل المؤثرة علي الإصابة بمرض سرطان الثدي في الفترة من ٢٠١٥-٢٠٢١م

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ملخص:

تهدف هذه الدراسة إلي استخدام نموذج انحدار كوكس لمعرف العوامل المؤثرة على الإصابة بمرض سرطان الثدي ونسبة تعرض المصابين بالمرض لخطر الوفاة، وتم استخدام المنهج التحليلي باستخدام برنامج spss16 للوصول الى نتائج الدراسة ، وتوصلت الدراسة الى أن نموذج انحدار كوكس المقدر لبيانات الدراسة نموذج معنوي ويمثل البيانات بصورة جيدة، وأن العوامل(وزن المريض ، العامل الوراثي، انتشار الورم في الغدد الليمفاوية ، مرحلة انتشار المرض ، عمر المصاب) لها تأثير معنوي على الإصابة بمرض سرطان الثدي وخطر الوفاة ، كما توصلت الدراسة الى ان العوامل (جنس المصاب، الحالة الاجتماعية، عامل الرضاعة، هرمون الإستروجين ، هرمون البروجسترون) لا تؤثر معنوياً على الإصابة بمرض سرطان الثدي .

الكلمات المفتاحية : نموذج انحدار كوكس ، خطر الوفاة ، اختبار Wald

Abstract

This study aims to using Cox regression model to identifying the factors that cause breast cancer and the risk of death for patients with the disease On the other hand، the analytical approach was used using the spss16 program to reach the results of the study، the study reached to the assessed model of Cox regression for the model of the data of the study is a significant model and represents the data well، and that the factors such as :(the patient's weight، the genetic factor، the spread of the tumor in the lymph nodes، the stage of the spread of the disease and the age، the patient) have a significant effect on the incidence of breast cancer and the risk of death، the study has also concluded that the factors such as (gender، marital status، location factor، estrogen, and progesterone) do not have a significant effect on the incidence of breast cancer.

Keywords: ***Risk of death, Cox regression mode, wad test***

مقدمة :

انتشر مرض سرطان الثدي في الفترة الأخيرة بصورة كبيرة في السودان , ويعتبر هذا المرض من الأمراض الخطيرة التي تؤدي الى الوفاة خاصة في حالة تأخر اكتشافه في مراحله الأولى, لذلك كان لابد من عمل دراسة تمكننا من معرفة أهم العوامل التي تؤثر على الإصابة بمرض سرطان الثدي , حيث تهدف هذه الدراسة الى استخدام نموذج انحدار كوكس لمعرفة العوامل التي تؤثر على الإصابة بمرض سرطان الثدي ونسبة تعرض المصابين لخطر الوفاة , ويعتبر نموذج انحدار كوكس من النماذج الإحصائية لتحليل زمن البقاء , ولأهمية موضوع زمن البقاء ظهرت الحاجة الماسة لتطوير الأساليب والوسائل الإحصائية لزيادة الدقة والمعرفة الشاملة بالعوامل المؤثرة علي بقاء المصاب حياً أو ميتاً.

نموذج كوكس Cox Model

الاستعراض النظري لنموذج انحدار كوكس

يعتبر نموذج انحدار كوكس Cox Regression Model الذي وضعه العالم Cox عام 1972م والذي يسمى أيضاً نموذج المخاطرة النسبية Cox Proportional Hazards Model (PHM) , من أهم النماذج الحديثة و أوسعها استخداماً في تحليل بيانات البقاء علي قيد الحياة Survival Data Analysis , كما يستخدم في مجالات أخرى بصورة جيدة , فهو نموذج يأخذ بالاعتبار تأثير بيانات المراقبة Censored Data , فهو تقنية إحصائية لاستكشاف العديد من المتغيرات التفسيرية وبقاء المريض علي قيد الحياة في البحوث الطبية[٤] .

والمتغيرات التفسيرية متغيرات مستقلة لا يضع النموذج أي شروط حول طبيعتها فقد تكون كمية أو وصفية أو مختلطة , ويفترض أن يكون لها تأثير على متغير الدراسة.

والميزة التي يتمتع بها نموذج انحدار كوكس من حيث الانتشار و الاستخدام تكون لعدة أسباب قد نجمل بعضها تحت مسمي خصائص نموذج انحدار كوكس والتي تتلخص في النقاط التالية :

- شكل النموذج يعتمد علي معدل الخطورة Hazard Ratio عند الوقت t .
- المخاطرة المقدرة دائماً غير سالبة وذلك لان قيم أي خطر يجب أن تكون محصورة بين الصفر و ما لا نهاية $0 \le h(t) < \infty$.
- يعنى نموذج كوكس بتأثير المتغيرات علي معدل الخطورة ولكنه يترك معدل الخطر الأساسي غير محدد .

- على عكس النماذج المعلمية فان نموذج انحدار كوكس لا يحتاج الى أي فرضيات حول شكل دالة الخطر الأساسية وكما أنها غير محددة فهاتان الخاصيتان تجعلان نموذج انحدار كوكس نموذج شبه معلمي [٥] .
- يستطيع نموذج انحدار كوكس استيعاب قياسات منفصلة أو متصلة لأوقات البقاء [6] .

صيغة نموذج انحدار كوكس

وتكتب الصيغة العامة لنموذج انحدار كوكس بالصورة التالية:

$$h(t) = h_0(t)\exp(\sum_{i=1}^{p} X_i B_i) \qquad (1)$$

حيث أن :

$h_0(t)$: تشير الى دالة الخطر الأساسية Baseline Hazard Function عند x=0 .

B_i : مصفوفة معاملات النموذج الغير معلومة .

X_i :مصفوفة المتغيرات المستقلة "التفسيرية".

وحيث أن المقدار $\exp(\sum_{i=1}^{p} X_i B_i)$ يشير الى دالة الخطورة النسبية والتي يمكن استبدالها بأي دالة معرفة غير سالبة .

وكما يعتبر هذا الجزء من صيغة نموذج كوكس للمخاطر النسبية CPHM جذاب لأنه يضمن أن النموذج المقدر سوف يعطي دائماً دالة خطر مقدرة غير سالبة [5] .

وكذلك دالة الخطر الأساسية $h_0(t)$ تعتبر دالة غير محددة وغير سالبة .

فروض نموذج انحدار كوكس

الفرض الأساسي لنموذج انحدار كوكس هو أن المخاطرة نسبية بمعني انه يفترض أن معدل الخطورة ثابت من شخص الى شخص أخر داخل الدراسة ولا يعتمد معدل الخطورة على الزمن .

يفترض نموذج انحدار كوكس CPHM عدم ثبات دالة المخاطرة الأساسية , ويتم تقديرها فقط من خلال الاعتماد علي وقت حدوث الحدث , كما أن المتغيرات المستقلة (التفسيرية) ترتبط بشكل خطي مع لوغاريتم دالة الخطورة .

تفسير معاملات نموذج انحدار كوكس:

الهدف الأساسي من استخدام نموذج الأخطار النسبية هو تقدير تأثير متغيرات الدراسة علي وقت البقاء , فالمعاملات المقدرة للمتغيرات توضح نسبة التغير في المتغير التابع لكل تغير بمقدار وحدة واحدة في المتغير المستقل , حيث أن لوغاريتم دالة الخطورة هي الدالة المستخدمة لتقييم تأثير التغير في المتغيرات .

والتي عادة تكون بالصيغة التالية [٢]:

$$h(t) = h_0(t)\exp(XB)$$

$$\log h(t) = \log(h_0(t)) + (XB) \qquad (2)$$

كذلك يتم استخدام نسبة الخطر Hazard Ratio لدراسة تأثير المتغيرات المستقلة علي المتغير التابع والتي تعرف بالصيغة التالية:

$$HR = \frac{\hat{h}(t, x^*)}{\hat{h}(t, x)}$$

$$= \frac{\hat{h}_0(t)\exp(\sum_{i=1}^{p} BX_I^*)}{\hat{h}_0(t)\exp(\sum_{i=1}^{p} BX_I)}$$

$$= \exp(\sum_{i=1}^{p} B(X_i^* - X_i))\cdots\cdots, i = 1, \cdots\cdots, p \qquad (3)$$

حيث أن :

$$X^* = X_1^*, X_2^*\ldots\ldots, X_P^*$$

$$X = X_1, X_2, \ldots\ldots, X_P$$

وتشير HR الى الخطر لشخص واحد مقسوم علي خطر شخص آخر مختلف ومن اجل التفسير عادة نأخذ $HR \geq 1$, وهذا يعني

$$\hat{h}(t,x^*) \geq \hat{h}(t,x)$$

ونلاحظ من المعادلة (٣) أنه تم إلغاء دالة الخطر الأساسية وكما أن نسبة الخطر لا تعتمد علي الزمن .

تقويم ملائمة نموذج انحدار كوكس:

بعد تقدير معلمات نموذج انحدار كوكس واختبار فرض المخاطرة النسبية يتم اختبار معنوية النموذج وقوته , بمعنى الى أي مدى النموذج الذي تم توفيقه ملائم لبيانات الدراسة.

وبعد التحقق من ملائمة النموذج يتم اختبار معنوية معاملات النموذج المقدرة بعدة اختبارات , وسنتعرض فيما يلي الى طرق التحقق من ملائمة النموذج وذلك على النحو التالي :

اختبار معنوية النموذج الكلي:

يعد اختبار نسبة الإمكان Likelihood Ratio Test من أهم الاختبارات التي تستخدم للتحقق من معنوية النموذج الموفق الكلي والذي سنتطرق له لاحقاً , ولكن الجدير بالذكر ان هناك أسلوب آخر يستخدم لتقييم النموذج الموفق الكلي وهو أسلوب بياني يعتمد علي الشكل البياني للأخطاء , بالرغم من عدم أهميته في نموذج الانحدار الخطي إلا انه يلعب دوراً مهماً لتقييم النموذج الكلي في تحليل البقاء بصورة عامة وفي انحدار كوكس للأخطار النسبية بصورة خاصة [١].

اختبار معنوية معاملات نموذج انحدار كوكس :

اختبار والد Wald Test :

لاختبار الدالة الإحصائية لكلل معامل من معاملات النموذج أي بمعني اختبار تأثير كل متغير مستقل داخل النموذج في وقت البقاء , حيث كل متغير مستقل تصاحبه معلمة واحدة .

واختبار والد يضع فرضية صفرية تدعي أن المعلمات تساوي الصفر أي

$$H_0 : B_i = 0$$

وبشكل عام الصيغة الرياضية لاختبار والد تكون كالتالي:

$$W_j = \left(\frac{B_j}{SE_{Bi}} \right)^2 \qquad (4)$$

حيث أن :

B_j : معامل النموذج المقدر .

SE_{Bi} : الانحراف المعياري المقدر .

بالتالي اختبار والد هو عبارة عن قسمة المعامل المقدر علي الانحراف المعياري المقدر , وأن نتيجة إحصاءة الاختبار تتبع توزيع مربع كاي X^2 بدرجة حرية واحدة(١).

المناقشة والنتائج :

تحليل نموذج انحدار كوكس:

اختبار معنوية النموذج ككل:

جدول (١) يوضح كفاءة نموذج انحدار كوكس

القيمة الإحتمالية	درجة الحرية	اختبار مربع كاي	-Log Likelihood
0.000	10	119.747	956.672

المصدر: اعداد الباحث من تحليل بيانات الدراسة باستخدام برنامج spss16

الجدول (١) يوضح كفاءة نموذج انحدار كوكس ككل وجودته باستخدام نسبة الإمكان الأعظم والذي يتبع توزيع مربع كأي بدرجة حرية 10 . ويتضح من خلال الجدول (١) ان قيمة مربع كاي معنوية وذلك لان القيمة الاحتمالية تساوي ٠,٠٠٠ وبما أنها اقل من قيمة مستوي المعنوية ٠,٠٥ فهذا يعني رفض فرض العدم القائل النموذج غير معنوي وقبول الفرض البديل القائل بأن النموذج معنوي مما يؤكد كفاءة ومعنوية النموذج مما يعني ان النموذج يمثل البيانات بصورة جيدة.

اختبار مساهمة متغيرات نموذج انحدار كوكس علي المتغير التابع:

تم اختبار نسبة مساهمة المتغيرات المستقلة علي المتغير التابع بواسطة معاملات التحديد Nagelkerke R Square والذي تم إيجاده باستخدام الصيغة الرياضية (٥) كما يلي:

$$R^2_{cs} = 1 - \left[\frac{L_R}{L_F}\right]^2 \div N \qquad (5)$$

حيث أن:

L_R: تمثل قيمة الإمكان الأعظم لنموذج انحدار كوكس عندما يحتوي النموذج علي الثابت فقط.

L_F: تمثل قيمة الإمكان الأعظم لنموذج انحدار كوكس عندما يحتوي النموذج علي كل متغيرات الدراسة.

N: تمثل عدد المشاهدات سواء كانت مراقبة ام لا .

$$R^2_{cs} = 1 - \left[\frac{1092.165}{956.672}\right]^2 \div 234 = 0.994$$

والنتيجة موضحة في الجدول (٢)

Step1	-Log Likelihood(LR)	-Log Likelihood(LF)	R Square
١	1092.165	956.672	0.994

المصدر: إعداد الباحث من تحليل بيانات الدراسة باستخدام برنامج spss16

من الجدول (٢) يتضح بأن قيمة (R Square) هي ٠,٩٩٤ مما يعني أن ٩٩,٤% من التغيرات التي تحدث في المتغير التابع (حالة المصاب) يتم تفسيرها بواسطة نموذج الإنحدار المقدر.

تكوين نموذج انحدار كوكس واختبار معاملاته:

تم اختبار معنوية معالم نموذج انحدار كوكس من خلال اختبار والد كما موضح بالجدول (٣)

جدول (٣) تكوين نموذج انحدار كوكس واختبار معاملاته

	B	Wald	Sig	EXP(B)
Weight1	٠,٦٥٢	**7.479**	**0.006**	**1.919**
Social status	**-0.080**	**0.724**	**0.395**	**0.923**
Lactation	**-0.713**	**0.743**	**0.389**	**0.490**
Procreation	**0.697**	**0.718**	**0.397**	**2.008**
Family history	**0.806**	**6.623**	**0.010**	**2.239**
Lymph	**1.028**	**9.002**	**0.003**	**2.796**
Grade stage	**0.473**	**12.720**	**0.000**	**1.605**
ER	**-0.217**	**0.819**	**0.365**	**0.805**
PR	**-0.002**	**0.000**	**0.993**	**0.998**

Age	**0.304**	**9.298**	**0.002**	**1.356**

المصدر: إعداد الباحث من تحليل بيانات الدراسة باستخدام برنامج spss16

من الجدول (٣) ومن خلال العمود الأول يتضح ان القيم التقديرية للمعلمات

($\hat{B}_1, \hat{B}_2, \hat{B}_3, \hat{B}_4, \hat{B}_5, \hat{B}_6, \hat{B}_7, \hat{B}_8, \hat{B}_9, \hat{B}_{10}$)، أي أن معادلة نموذج انحدار كوكس التقديرية ستكون بالشكل التالي:

$$\hat{h}(t,x) = \hat{h}_0(t)EXP0.65x_1 - 0.08x_2 - 0..713x_3 + 0.697x_4 + 0.806x_5 + 1.028x_6 + 0.473x_7 - 0.17x_8 - 0.002x_9 + 0.304x_{10}$$

أما العمود الثاني فيوضح القيمة المحسوبة لاختبار والد (Wald), والعمود الثالث يوضح القيم الإحتمالية لاختبار والد والتي من خلالها يتم اتخاذ القرار بقبول أو رفض فرض العدم، وبما أن القيم الإحتمالية لكل من (X_1 , X_{10} , X_7 , X_5 , X_6) هي أقل من قيمة مستوي المعنوية ٠,٠٥ عليه يتم رفض فرض العدم القائل بأنه لا يوجد تأثير للمعلمة علي المتغير التابع وقبول الفرض البديل القائل بأنه يوجد تأثير للمعلمة علي المتغير التابع ,وبما أن القيم الإحتمالية لكل من (X_2 , X_9 X_3 , X_4 , X_8 ,) هي أكبر من قيمة مستوي المعنوية ٠,٠٥ عليه يتم قبول فرض العدم القائل بأنه لا يوجد تأثير للمعلمة علي المتغير التابع ورفض الفرض البديل القائل بأنه يوجد تأثير للمعلمة علي المتغير التابع أي أن:

$$H_0 : \beta_i = 0$$
$$H_1 : \beta_i \neq 0$$

ونستدل علي أن معلمات النموذج المقدر (وزن المصاب، العامل الوراثي،انتشار الورم في الغدد الليمفاوية, مرحلة انتشار الورم, عمر المصاب) هي معنوية، أي لها تأثير علي المتغير التابع (حالة المريض) خلال الفترة الزمنية للمتابعة .

أما قيم العمود الرابع فتوضح مقدار التغير الحاصل في نسبة وقوع الحدث (خطر الوفاة) عند حدوث تغير في قيمة المتغير المستقل المرتبط بالمعلمة ($\hat{B}_i$)، فإذا كانت قيمة EXP(B) أكبر من الواحد الصحيح فإن نسبة الخطر سوف تزيد والعكس صحيح, عليه يكون شكل النموذج المقدر بعد استبعاد المتغيرات غير المعنوية كالأتي:

$$\hat{h}(t,x) = \hat{h}_0(t)EXP0.65x_1 + 0.806x_5 + 1.028x_6 + 0.473x_7 + 0.304x_{10}$$

بالنسبة للمتغير الأول X_1 (وزن المصاب): بما أن قيمة EXP(B) هي 1.919

هذا يعني أنه احتمال حدوث الوفاة بالنسبة لمتغير (وزن المصاب) تزيد بمقدار 1.919مقابل الزيادة في الوزن بمقدار وحدة واحدة .

بالنسبة للمتغير الخامس X_5 (العامل الوراثي): بما أن قيمة EXP(B) هي 2.239 هذا يعني أنه عند تغير متغير العامل الوراثي X_5 من عدم وجود عامل وراثي أي $X_2 = 0$ إلي وجود عامل وراثي $X_5 = 1$ فإن نسبة الخطر بأن يكون المصاب قد توفى ستكون أكبر بمقدار 2.239 مرة.

بالنسبة للمتغير السادس X_6 (انتشار الورم في الغدد الليمفاوية): بما أن قيمة EXP(B) هي 2.796 هذا يعني أنه عند تغير متغير انتشار الورم في الغدد الليمفاوية X_6 من عدم وجود ورم منتشر أي $X_6 = 0$ إلي وجود ورم منتشر $X_6 = 1$ فإن نسبة الخطر بأن يكون المصاب قد توفي ستكون اكبر بمقدار 2.796 مرة.

بالنسبة للمتغير السابع X_7 (مرحلة انتشار الورم): بما أن قيمة EXP(B) هي 1.605 هذا يعني أنه عند تغير متغير مرحلة انتشار الورم X_7 من المرحلة الطبيعية الى المرحلة الأولى أو المرحلة الثانية أو المرحلة الثالثة أو المرحلة الرابعة فإن نسبة الخطر بأن يكون المصاب قد توفى ستكون أكبر بمقدار 1.605 مرة.

بالنسبة للمتغير العاشر X_{10} (عمر المصاب): بما أن قيمة EXP(B) هي 1.356

هذا يعني أنه احتمال حدوث الوفاة بالنسبة لمتغير (عمر المصاب) تزيد بمقدار 1.356 مقابل الزيادة في العمر بمقدار سنة واحدة .وأخيرا نجد أن العمود السابع يوضح حدود الثقة لEXP(B).

الاستنتاجات :.—

1- نموذج نموذج انحدار كوكس المقدر لبيانات الدراسة نموذج معنوي ويمثل البيانات بصورة جيدة.

2- العوامل (وزن المريض , العامل الوراثي , انتشار الورم في الغدد الليمفاوية , مرحلة انتشار المرض , عمر المصاب) لها تأثير معنوي على الإصابة بمرض سرطان الثدي وخطر الوفاة .

3- العوامل (جنس المصاب, الحالة الاجتماعية, عامل الرضاعة, هرمون الإستروجين , هرمون البروجسترون) لا توثر معنوياً على الإصابة بمرض سرطان الثدي .

التوصيات:

1- استخدام وتطبيق نموذج انحدار كوكس للتعرف علي العوامل المؤثرة بالإصابة بمرض سرطان الثدي لدقة نتائجه

2- عمل دراسات عن نموذج انحدار كوكس للأخطار النسبية المتعدد وذلك بغرض المقارنة بين أكثر من فترة متابعة واحدة.

3- ضرورة إجراء الفحص المبكر لمرض سرطان الثدي , حيث أكدت الدراسة من خلال النتائج ان اكتشاف المرض في مراحله المتأخرة يكون فيها المريض أكثر عرضة لخطر.

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Effectiveness of Educational Program on Nurses knowledge regarding Emergency Crash Cart medication management in Governmental Cardiac Centers Khartoum State Sudan 2019-2022

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Abstract

Background: According to the Joint Commission, crash cart-related patient safety issues are mixed-up medications, medication errors, damaged or expired medicines, improper checking of crash cart and non-competent staff. and enables health care providers to manage medical emergencies easily and confidently. **Aim:** To study effectiveness of the Educational Program on Nurses' knowledge regarding Emergency Crash Cart medication management. **Methods:** An interventional Hospital based study pre –post-test design carried out at Governmental Cardiac Centers Khartoum State Sudan. the total coverage sample (132) nurses were participate in the study. Data collected using a standardized questionnaire Pre and post Educational Program. **Results:** the percent of disagree and Strongly disagree are high in pre nurses knowledge 43.9 % strongly disagree, disagree 25.6 % ,while post Educational Program results strongly agree 44% , Agree33% .There were statistically significant differences between the nurse's knowledge, as the calculated (T) value reached, -13.33, in pre measurement ,-18.30 in post measurement which is a statistically significant value at the level of significance.01, where the Sig value is (.00). There is a statistically significant increase in the degree of nurses' knowledge in the post-measurement)

Keywords: Emergency; Crash Cart; Medication management; Educational program; Knowledge; Nurses

Introduction

The fact that nurses frequently "float" between various patient care units can have an impact on their performance and confidence during a code since they are unfamiliar with the layout of the code cart . (1)As a result, immediate access to a defibrillator, resuscitation drugs, supplies, and equipment should be simple and quick, and crash carts

need to be meticulously outfitted, maintained, and organized. (2)To decrease the possibility of medication errors, shorten the time it takes to retrieve medications, and ensure that the medications are properly labeled by The Joint Commission's (TJC) medication management standard.(3) The National Accreditation Board of Hospitals and Health Care Providers (NABH) sets standards and justifies obligatory regulations for effective access to emergency medication, including sufficient medication storage in a standardized manner across the institution. (4) Additionally, it suggests a daily check system guaranteeing proper stock levels, expiration date tracking, paperwork to establish employee accountability, and locking mechanisms to deter theft. (5)in cardiac arrest situations, every minute's delay in resuscitation can lead to a drop in successful outcomes by 7%–10%.(8)

Hypothesis

1. No Significant difference in the nurse's performance after the educational program.
2. Significant difference Nurse's performance enhanced after the educational program

2. Methodology

Study design :- An interventional Hospital based study with a pre intervention and post intervention assessment designed was conducted during the 2019- 2022.

Study area and setting : -Was carried out in Khartoum State Sudan Governmental Cardiac Centers at Ahmed Gasim and Shab Cardiac Centers in Coronary Care Unit (CCU1), Intensive Care Unit (ICU), Coronary Care Unit (CCU2) in Cardiac Center in Ahmed Gasim hospital. and Coronary Care Unit(CCU), Intensive Care Units(ICU), Intermediate Intensive Care Units (IICU) at the Shab Cardiac Center.

Study population : All nurses work in (Ahmed Gasim Cardiac and Shab Cardiac Center) were chosen

Inclusion criteria: Nurses were included in the study by the following eligibility requirements Gender : Males and Females both, holders of a bachelor's degree in nursing, Job type: a permanent position and Working departments include the Intensive Care Unit, Coronary Care Unit (1)and Coronary Care Unit(2)Ahmed Gasim Cardiac Center.

Intensive Care Unit, Intermediate Coronary Care Units, and Coronary Care Unit were employed by the Shab Cardiac Center.

Exclusion criteria: Nurses who do not attend the educational program three nurses were on holyday and sec live .

Sampling : Governmental Cardiac Centers in Khartoum State (Ahmed Gasim Cardiac and Shab Cardiac Center) were chosen as the sampling frame, along with a total coverage sample. Sample size 135 Nurses Complete the survey

Data collection Toll : The researcher created a pre and post-educational program questionnaire that included two parts. socio-demographic characteristics including age, gender, educational background, and level of experience. work environment and have received prior training in crash cart management. The second part is to evaluate nurses' knowledge of crash cart medication management . The scoring system: a Likert scale scores were used five points Strongly agree (5), Agree (4), Neutral (3), Disagree (2), and Strongly disagree (1). Before the educational program began the pre-data was collected, and three months later the post-program evaluation got started using the same questionnaire**.**

Data analysis: The researcher used several statistical treatments to process data, using the Statistical Package for Social Sciences (SPSS) program, Means: to find out the direction of differences between groups'-test one-tailed to reveal the general characteristic of the study variables. T-test two-tailed: to reveal the significance of the differences between the two groups When the P value is 0.05 percent or higher and the analysis plan is present, the results are considered valid. With regard to demographic data, the descriptive analysis concentrate on frequencies and identify differences across groups

Ethical Approval The study was approved by The Institutional Review Board (IRB) Nursing Colleges at AlNeelain University provided their approval for this study. The second approval from the IRB for the research division of the Khartoum State Ministry of

Health (SMOH). additionally, the study was approved by governmental hospitals Ahmed Gasim and Shab heart centers.

3.Results

Table No. (1) Distribution Demographic data for the studied nurses (N=132).

Variable	Socio-demographic data	Number	%
Gender	Male	40	%30
	Female	92	%70
Age	20 - 30	46	%35
	31 - 40	72	%54
	41-50	14	%11
Qualification	Bachelor	117	%89
	Master	15	%11

Table (1): Show that Most of nurses were female(70%) , hade aged between 23 to 40 years(54%) and about (89%) of them were Bachelor in nursing. regarding years of experience half of nurses (54%) were have experience 6-10 years .nurses disruption 55%were in coronary care units Most of Nurses (67%) hadn't received training before .

3.Results

Table No. (2) Distribution Demographic data for the studied nurses (N=132).

Variable	Socio-demographic data	Number	%
Experience	1 -5Y	42	%32
	6-10Y	71	%54
	15-11 Y	19	%14
Work place	Coronary Care Units	72	%55
	Intensive Care Unite	49	%37
	Inter media Intensive Care Unite	11	%8
have training before	Yes	44	%33
	No	88	%67

Table (1): Show that (54%) were have experience 6-10 years .nurses disruption 55%were in coronary care units Most of Nurses (67%) hadn't received training before .

Table No. (3) shows the pre educational program nurses knowledge regarding Crash Cart medication management (n=132).

NO	ITEMS	Strongly agree		Agree		Neutral		Disagree		Strongly disagree	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
1	the emergency crash cart have a list of medication	10	7.6	20	15.2	8	6.1	35	26.5	59	44.7
2	The medication checked based on expiry date ?	20	15.2	17	12.9	6	4.5	32	24.2	57	43.2
3	the medication arranged according to their action	19	14.4	17	12.9	7	5.3	37	28.0	52	39.4
4	the medication arranged in sequence and in order	14	10.6	14	10.6	6	4.5	33	25.0	59	44.7
5	the crash cart contain emergency drugs according to stander amount	19	14.4	9	6.8	4	3.0	29	22.0	71	53.8
6	Organizing of the medication in crash carts reduce of medication error	11	8.3	21	15.9	7	5.3	45	34.1	48	36.4
7	the emergency crash cart drugs Labeled to their action policy?	24	18.0	21	15.9	5	3.8	23	17.4	59	44.7
	Total		12.8 %		12.9 %		4.8 %		25.6 %		43.9%

The above table show that , most of participant were Strongly disagree in pre educational program Nurses knowledge about Crash Cart medication management 43.9 % ,disagree 25.6 % ,while strongly agree 12.8% and agree 12.9% (the percent of disagree and Strongly disagree are high There

is low of nurses' knowledge about Crash Cart medication management pre educational program).

Table No. (4) shows the post educational program nurses knowledge regarding Crash Cart medication management (n=132).

NO	ITEMS	Strongly agree		Agree		Neutral		Disagree		Strongly disagree	
		Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
1	the emergency crash cart have a list of medication	43	32.6	47	35.6	10	7.6	16	13.6	14	10.6
2	The medication checked based on expiry	64	48.5	33	25.0	6	4.5	11	8.3	18	13.6
3	the medication arranged according to their action	46	35.1	52	39.7	11	8.4	9	6.9	13	9.9
4	the medication arranged in sequence and in order	64	48.5	40	30.3	9	6.8	10	7.6	9	6.8
5	the crash cart contain emergency drugs according to stander amount	67	50.8	44	33.3	5	3.8	8	6.1	8	6
6	Organizing of the medication in crash carts reduce of medication error	65	49.2	47	35.6	3	2.3	5	3.8	12	9
7	the emergency crash cart drugs Labeled to their action policy?	53	40.2	42	31.8	9	6.8	17	12.9	11	8.3
	Total		44%		33%		5.7%		8.5%		9%

The above table show that , most of participant total percent Strongly agree in post educational program Nurses knowledge about Crash Cart medication management were 44% ,33% agree ,while 8.5 % Disagree and9% Strongly disagree. (the percent of agree and Strongly agree are high There

is increased of nurses' knowledge about Crash Cart medication management post educational program measurements).

Table No. (5) shows the pre /post educational program nurses knowledge regarding Crash Cart medication management(n=132).

No		Pre		Post	
		Mean	Std. Deviation	Mean	Std. Deviation
1.	the emergency crash cart have a list of medication	2.1439	1.33434	3.9242	1.33727
2.	The medication checked periodically based on expiry	2.3258	1.44504	3.8636	1.50570
3.	the medication arranged according to their action	2.3485	1.25975	3.8321	1.46712
4.	the medication arranged in sequence and in order	2.2197	1.23136	4.0530	1.42129
5.	the crash cart contain emergency drugs according to stander amount	2.0606	1.14696	4.1667	1.46594
6.	Organizing of the medication in crash carts reduce of medication erro	2.2576	1.21712	4.1212	1.32285
7.	the emergency crash cart drugs Labeled to their action policy?	2.4545	1.31053	3.8258	1.60326
Total		15.71	4.00	28.13	4.5

The above table show , that the differences between the mean in pre/ post educational program nurses knowledge regarding Crash Cart medication management the total mean in pre 15.71 in post increased to 28.13 and the Std. Deviation pre 4.00 post 4.5 (There is a statistically significant increased in the degree of nurses' knowledge in the post measurements).

Table (6) showing the result of (T) test- Statistics Pre- post educational program Nurses knowledge about Crash Cart Medications (n=132).

	N	Items	criterion Value	Mean	Std. Deviation	Df	(T)	Sig. (2-tailed)	Inference
Pre	132	(7)	21	15.71	4.5		-13.33	.000	Sig
Post	132	(7)	21	28.13	4.47		18.30	.000	Sig

The above table show, the differences between the mean and the criterion value are statistically significant, as the calculated (T) value reached, -13.33, in pre measurement, -18.30 in post measurement which is a statistically significant value at the level of significance.01, where the Sig value is (.00). That mean differences are statistically significant, In favor of the criterion value versus the mean, then the result is: There is a statistically significant increase in the degree of nurses' knowledge in the post-measurement)

4.Discussion

According to the current study , the majority of nurses were female, the majority of them had bachelor's degrees in nursing, and half of them had experience ranging from six to ten years. Percentage distribution participant nurses before Nurses knowledge about Crash Cart medication management 43.9 % of participant were Strongly disagree and 25.6 % disagree . Adverse events reporting study in gynecology and obstetrics area of an urban teaching hospital revealed total 82 events in 6 weeks period out of which 56% events were reported from obstetrics while remaining 44% were from gynecology [(12).] Total 1976 medication errors were reported in an observational study conducted upon 10000 women in obstetric emergency ward of a hospital in Egypt in 2010 [(13)] . have a list of medication 44.7 % , The medication checked periodically based on expiry 43.2 ,the medication arranged according to their action 39.4% , the crash cart contain emergency drugs according to stander amount 53.8 % , Organizing of the medication in crash carts reduce of medication error 36.4% and the emergency crash cart drugs Labeled to their

action policy 44.7. Crash Cart medication management the total mean in pre 15.71 in post increased to 28.13 and the Std. Deviation pre 4.00 post 4.5 (There is a statistically significant increased in the degree of nurses' knowledge in the post measurements). According to the Joint Commission, some of the factors leading to most of the crash cart-related patient safety issues are mixed-up medications, medication errors, damaged or expired medicines, improper checking of crash cart as per policies and procedures and non competent staff .[14] There must be strengthened system for medicines management and expiry monitoring to prevent any health hazard in a healthcare system .[15] Once a medicine is expired, its safety and efficacy becomes uncertain as per U.S. Food and Drug Administration. [16.]Healthcare professionals must play their role in the monitoring of expired or deteriorated medicines in healthcare areas by following the approved international guidelines of treatment and rationalized usage of medications .[17] A similar study was conducted (2016) to assess the knowledge of critical care nurses related to essential crash cart trolley with basic emergency medications concluded that there is lack of knowledge related to essential crash cart trolley with basic emergency medications Thakur Sudarshan K.,TakAnjna, Bajaj Nisha (2018). similar study to assess the effectiveness of structured teaching programme on knowledge regarding utilization of crash cart trolley among III -B.Sc Nursing students Concluded the knowledge regarding crash cart trolley in pre-test. After providing structured teaching programme on utilization of crash cart trolley there is a significant improvement on knowledge of students regarding crash cart trolley. {S. Aruna and Kalaimathy K. and G.Sivasakthi Raman},

5.Conclusion

According to the completed study, standardization in the crash carts may be fully adopted in terms of labeling and documentation protocols to promote visibility and staff accountability to manage situations efficiently. Additionally, it demonstrated how difficult it was to bring about change in clinical practice when it came to the management of emergency equipment so that new procedures for checking and maintaining emergency equipment might be established.

6.Recommendations

Following are some recommendations that are offered based on the findings of the present study: Ongoing training initiatives to keep nurses working in emergency rooms up to speed on their knowledge and abilities. To generalize the findings, the study may be replicated with larger sample size and in a different hospital context. An intermittent assessment of critical care nurses' knowledge and skills regarding various nursing practices at the intensive care units. The system of inspecting, changing, and repairing the emergency trolleys' equipment might be made better by developing the Standard Operating Procedures in-service training.

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The Bacterial Quality of Food Served to Patients at Hospitals of Khartoum Locality, Khartoum State, Sudan.

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Abstract:

A descriptive cross sectional hospital based study was conducted in 12 hospitals at Khartoum Locality, Khartoum State, Sudan from May2016 to September 2018. The study aimed to determine the level of microbial quality of food prepared and served to patients in the hospitals. A total of 300 food contact surface swabs and 36 of food samples prepared and served to patients were collected for microbiological examination. The microbial growth were detected in (84.7%) of food contact surfaces. *Staph epidermis* were detected in (40%) of food contact surfaces mainly workers hands**,** knives and food utensils*; pseudomonas species* in (48%) mainly benches, food shelves and knives and *Coliform* (12%) from benches and utensils. The bacteriological findings of food prepared and served to patients revealed (52.8%) samples positive for bacterial growth, (68.4%) of these were of APC range 3×10^2-1×10^3, whereas (31.6%)were positive for *Staphylococcus aureus coagulase +ve* with APC range of 3×10 - 3×10^2. This APC were found to be within the limits of the SSMO for acceptable ready to eat food but indicate some hygiene problems. The study recommended the hospitals to endeavor adoption of Hazard Analysis Critical Control Points (HACCP). Such approach will definitely ensure the quality and safety of food served to patients in the hospitals.

Introduction:

Safe food served to patients in hospitals is an essential part of patients care that encourage patients to be well and due to this hospitals have been considered as one of the institutions of high food safety risk since they served food to vulnerable people. Food contamination by pathogens could be particularly harmful. In hospital catering, food services staff is the main food handlers although nurses and other domestic staff may distribute or serve meals. (1). Food handler's staff in hospitals may possibly introduce pathogens into food during every phase from purchase to distribution. (2).

Nosocomial food borne outbreaks in hospitals is attributed to poor hygiene in the system of preparation, distribution of food, and poor personal hygiene of food handlers (3).

The most common causes of food bone infections in hospitals are improper holding time or temperature, contaminated equipments, poor personal hygiene, and food from unsafe sources (4).

The prevention and control can be made through strict implementation of food hygiene and safety systems.The present study aims to determine the level of microbial quality of food served to patients in hospitals of Khartoum Locality, Khartoum State, Sudan.

Materials and Methods:

Three hundred swab samples were taken from the surface area that was in contact to food while processing. From each hospital kitchen 25 swab samples were collected as 5 samples for each of food shelves, benches, food utensils, knives and hands of workers. A total of 36 samples of prepared and served food to patients were collected under aseptic conditions with frequency of 3food samples from each hospital kitchen. Food served to patients is Sudanese traditional meals and were typed as the material sources consistency into: legume based sauces, vegetable based foods and amylaceous. The three samples from each hospital kitchen were taken at breakfast, dinner and supper meals. Each food sample being 100 grams were placed in sterilized plastic bags and kept in ice box during transport to Food and Water Microbiology Department at the National Health Laboratory-Khartoum-Sudan (5). The microbiological methods used were the generalization of statutory tests in Department of Food and Water (6). All food contact surfaces were tested for the presence of bacterial growth and identification of the isolates. On the other side all food samples were tested for the presence of bacterial growth, Aerobic Plate Count, then for detection and enumeration of Aerobic Plate Count for S*taphylococcus aureus Coagulase positive.* Analysis of the bacteriological findings of the food samples used was taken from the microbial safety standards of some international regulations for specific types of foods (7),(8),(9),(10). Ethical clearance was obtained from Khartoum State Ministry of Health. Formal letters was given to each hospital medical director informing the purpose of the study and consent were obtained.

Results:

Table (1); The frequency of isolation of species of bacteria from different types of food contact surfaces (n=60 for each type).

Food contact surface\species of bacteria	Knives	Benches	Shelves	Utensils	Hands
Staphylococcus epidermis	41(68.3%)	**0**(0%)	**0**(0 %)	56(93.3%)	23(38.3%)
Pseudomonas aeruginosa	22(36.7%)	47(78.3%)	51(85%)	23(38.3%)	0(0%)
Coliform	0(0%)	37(61.7%)	0(0%)	0(0%)	0(0%)

The microbial growth were detected in 254(84.7%) out of 300 food contact surface swabs. Knives, benches, and utensils showed 100% bacterial growth meanwhile hands and shelves showed bacterial growth in 38.3% and 85% respectively. More than one bacterial species were shown in samples of Knives benches and utensils meanwhile only one species of bacteria were shown in hands and shelves

Table (2); the positive bacterial growth and the Aerobic Plate Count of food samples (n=12 for each type of food).

Type of food	Positive food samples	CFU/gm^3
Legumes	4(33,3%)	1×10^3
Vegetables	5(41,7%)	3×10^2
Amylaceous	4(33,3%)	3×10^2

SSMO of Vegetables $=10^2$ to 10^4

SSMO of Amylaeous $=<10^4$ to 10^5

The bacterial growth was detected in 13(36.1%) of food prepared and served to patients in hospitals. The Aerobic Plate Count of these positive revealed a range of 3×10^2 -1×10^3CFU/gm^3.

Table (3): The frequency of isolation and Aerobic Plate Count of *Staphylococcus aureus coagulase +ve* in food prepared and served to patients . (n=12 for each type of food)

Type of food	Positive food samples for *Staph.aureus*	CFU/gm^3
Legumes	3(25%)	3×10
Vegetables	2(16.7%)	3×10^2
Amylaceous	1(8.3%)	3×10^2

Staphylococcus aureus coagulase +ve were recovered from 6 food samples of the positive bacterial growth with a range of 3×10 in legumes and 3×10^2 for each of vegetables and amylaceous.

Acceptable limit (7) (Ready to eat foods) 10^2 to 1× 10^3

Discussion:

The high percentage (84.7%) of the presence of microbial growth in the different types of food contact surfaces indicated improper cleaning and that the utensils, equipment's, knives and shelves were stored under conditions which did not prevent contamination. The presence of *Coliforms* in (61.7%) benches of the hospital kitchens indicates potential hazard. The study showed that (52.8%) of ready to eat- food samples were positive for microbial growth. This indicated high percentage contamination of ready to eat food for patients in the hospitals. The possible sources of food contamination were attributed to the contamination of the food contact surfaces. According to (8), (9), such contaminated surfaces and the direct contact with the prepared food would be a major reason for microbial contamination of food. About (68.4%) of those detected with bacterial contamination revealed APC in the range of 3×10^2 for 41.7 % samples of vegetables and in the range of 3×10^2 for both 33.3 % samples of each of amylaceoues and legumes. This APC were found to be within the limits of acceptable ready to eat food (7). The microbiological testing for detection of the presence of certain pathogens in ready to eat food revealed (31.6%) food samples with *Staphylococcus aureus Coagulase positive.* The types of food encountered with this pathogen included 25 % of legumes, 16.7% of vegetables and 8.3% of amylaceous. The presence of *Staphylococcus aureus Coagulase positive* in such ready-to-eat food of this study is potentially hazardous for patients in the

hospitals. Their presence may be due to improper personal hygienic practices of not washing hands before or after touching cooked foods Comparing this finding with other previous studies done in France (11) and Turkey (12) similarity were found.. Actions were needed for correction in such a way that hospitals should have their food handling controls investigated, ensure well hygiene practices and determine the sources of contamination, cleaning and disinfection procedures used in the hospital kitchens.

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Application on Approximate Controllability of Semi-Linear Neutral Integro-Differential Equations with Nonlocal Conditions

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Abstract:

For validity we show an applicationon the approximate controllability of a semi-linear neutral integro-differential equation with nonlocal conditions by theory of analytic semi-groups, fractional powers of operators, and resolvent operator theory,considered by Hai Huang and Xianlong Fu1 [1]. Under the assumption of controllability on the corresponding linear system, we obtain the sufficient conditions for the considered semi-linear integro-differential system. In particular, the compactness condition or Lipschitz condition for the function g in the nonlocal condition appearing in literature is not required here. An example is also provided to illustrate the application of the obtained results.

Keywords: Neutral integro-differential equation, Approximate controllability, Resolvent operator, Fractional power operator, Nonlocal condition system.

1 Introduction

We show the approximate controllability of the following semi-linear neutral integro-differential equation with nonlocal conditionconsidered by Hai Huang and Xianlong Fu1 [1]:

$$\begin{cases} \dfrac{d}{d(1+\epsilon)}\left[x_r(1+\epsilon)+F\left(1+\epsilon,x_r\left(h_1(1+\epsilon)\right)\right)\right]=-Ax_r(1+\epsilon) \\ +(1+\epsilon)\displaystyle\int_{\gamma}^{0}(1+\epsilon-s)x_r(s)ds+G\left(1+\epsilon,x_r\left(h_2(1+\epsilon)\right)\right)+Bu(1+\epsilon), \qquad \epsilon\geq -1, \\ x_r(0)+g(x_r)=(x_r)_0, \end{cases} \tag{1}$$

where the state variable $x_r(\cdot)$ takes values in a Hilbert space X and the control function $u(\cdot)$ is given in the Banach space $L^2([0,1+2\epsilon];U)$ with U also a Hilbert space. The (unbounded) linear operator $-A$ generates an analytic semigroup on X. B is a bounded linear operator from U into $X, \gamma\ (1+\epsilon)$ is a family of closed linear operators, F, G, g, h_1 and h_2 are given functions to be specified later.

Grimmer et al. [2–3] proved the existence of solutions of the following integrodifferential evolution equation in Banach space X:

$$\begin{cases} v'(1+\epsilon) = Av(1+\epsilon) + \int_0^{1+\epsilon} \gamma(1+\epsilon-s)v(s)ds + f\,(1+\epsilon), & \epsilon \geq -1\,, \\ v(0) = v_0 \in X, \end{cases} \quad (2)$$

where $f: \mathbb{R}^+ \to X$ is a continuous function. The author(s) showed the representation, existence, and uniqueness of solutions of equation (2) via the resolvent operator associated to the following linear homogeneous equation:

$$\begin{cases} v'(1+\epsilon) = Av(1+\epsilon) + \int_0^{1+\epsilon} \gamma(1+\epsilon-s)v(s)ds, & \epsilon \geq -1\,, \\ v(0) = v_0 \in X. \end{cases}$$

The resolvent operator, replacing the role of C_0-semi-group for evolution equations, plays an important role in solving (2) in weak and strict senses. For example, in [4, 5, 6, 7], the authors have investigated the existence of solutions of this kind of equations, while the equations of stability and (almost) periodicity were explored respectively in [8, 9] and [10, 11].

As well known, controllability is one of the elementary concepts in mathematical control theory. Roughly speaking, controllability means that we can steer the state of dynamical system to an appropriate state by the control function existing in the equation (see [12,13]). The equation of controllability for various types of integro-differential systems has been extensively studied by mathematicians recently (we can refer to [14, 15, 16, 17]). Dieye et al. [18] studied the exact controllability for integro-differential equations in a real separable Hilbert space driven. Yang et al. [19] considered the exact controllability for a class of integro-differential evolution equations involving nonlocal initial conditions in Banach spaces. However, as stated in [20], the concept of exact controllability is very limited to infinite-dimensional systems. In [21], Bashirov and Mahmudov presented a so-called resolvent condition for the approximate controllability which is actually equivalent to the approximate controllability of linear equations. Since this condition is convenient to be applied, it is widely used to study the controllability equations for nonlinear controlled systems in infinite dimension (see [22, 23, 24, 25, 26]. Mokkedem and Fu [24] established the sufficient conditions for the approximate controllability of following semi-linear neutral integro-differential equations with finite delay:

$$\begin{cases} \dfrac{d}{d(1+\epsilon)}[x_r(1+\epsilon)+F\,(1+\epsilon,(x_r)_{1+\epsilon})] = -Ax_r(1+\epsilon)+\displaystyle\int_0^{1+\epsilon}\gamma\,(1+\epsilon-s)x_r(s)ds \\ \qquad +G(1+\epsilon,(x_r)_{1+\epsilon})+Bu(1+\epsilon), \qquad \epsilon\geq -1, \\ (x_r)_0=\phi, \qquad t\in[-r,0]. \end{cases}$$

The main techniques are utilizing the resolvent condition and fixed point principle.

Nonlocal initial condition is much better than the classical initial condition $x_r(0)=(x_r)_0$ when used to describe some physical phenomena. The nonlocal Cauchy equation of evolution equations was studied by Byszewski et al. [27] and the importance of nonlocal conditions in different fields has been discussed in [27], [28] and various papers (see [29, 30, 31, 32, 33, 34, 35, 36, 26–37]). Chang and Liu [29] proved the existence of mild and strong solutions for some neutral partial differential equations with nonlocal conditions in the α-norm. [35] considered the following semi-linear integro-differential equations with nonlocal Cauchy equation:

$$\begin{cases} u'(1+\epsilon)=A\left[x_r(1+\epsilon)+\displaystyle\int_0^{1+\epsilon}F(1+\epsilon-s)u(s)ds\right]+f\big(1+\epsilon,u(1+\epsilon)\big),\epsilon\geq -1, \\ u(0)+g\left(t_1,\cdots,t_p,u(t_1),\cdots,u\big(t_p\big)\right)=u_0. \end{cases} \tag{3}$$

There they studied the existence, uniqueness, and regularity of mild solutions of equation (3) using a fixed point principle. In [26], Vijayakumar discussed the approximate controllability for the following neutral integro-differential equations with nonlocal condition:

$$\begin{cases} \dfrac{d}{d(1+\epsilon)}\big[x_r(1+\epsilon)+g\big(1+\epsilon,x_r(1+\epsilon)\big)\big]=A\left[x_r(1+\epsilon)+\displaystyle\int_0^{1+\epsilon}G(1+\epsilon-s)x_r(s)ds\right] \\ \qquad +F\big(1+\epsilon,x_r(1+\epsilon)\big)+Bu(1+\epsilon), \qquad \epsilon\geq -1, \\ x_r(0)+h\big(x_r(1+\epsilon),x_r(1+2\epsilon),\cdots,x_r(1+p\epsilon)\big)=(x_r)_0, \end{cases} \tag{4}$$

where $h: I^p\times X\to X$ is a given function. The author obtained the approximate controllability result for equation. (4) under the assumptions that h satisfied Lipschitz condition and the corresponding linear system of equation. (4) is approximately controllable. In [26], Vijayakumar also studied the approximate controllability for a class of fractional differential inclusion with nonlocal conditions, where the linear part is nondensely defined and satisfies the Hille–Yosida condition.

Hai Huang and Xianlong Fu1 [1] discuss the approximate controllability of the integro-differential equation (1). A motivation of this paper is the approximate controllability equation of the following neutral partial integro-differential control equation:

$$\begin{cases} \dfrac{\partial}{\partial(1+\epsilon)}\left[z(1+\epsilon,x_r)+F\left(1+\epsilon,z(\cdot,x_r),\dfrac{\partial}{\partial x_r}z(\cdot,x_r)\right)\right]=\dfrac{\partial^2}{\partial x_r^2}z(1+\epsilon,x_r) \\ \qquad\qquad +\displaystyle\int_0^{1+\epsilon} b(1+\epsilon-s)\frac{\partial^2}{\partial x_r^2}z(s,x_r)ds \\ \qquad +G\left(1+\epsilon,z(\cdot,x_r),\dfrac{\partial}{\partial x_r}z(\cdot,x_r)\right)+Bu(1+\epsilon), \qquad 0\le x_r\le\pi, \qquad \epsilon\ge -1\,, \\ z(1+\epsilon,0)=z(1+\epsilon,\pi)=0, \qquad \epsilon\ge -1, \\ z(0,x_r)+g(z(1+\epsilon,x_r))=z_0(x_r), \qquad 0\le x_r\le\pi. \end{cases} \tag{5}$$

This system arises in the study of heat flow in materials with nonlocal condition; here $z(1+\epsilon,x_r)$ represents the temperature of a conduct of the pointsx_r and time t. It can be rewritten as the abstract form Eq. 1. Another motivation is to develop the work in [24] to the systems with nonlocal conditions.

We shall first show the existence of mild solutions of equation (1) for different control functions, and discuss the approximate controllability equation applying the resolvent condition. We investigate the existence equation by restricting the mild solutions in a Hilbert space $X_{1+\epsilon}(\subset X)$ induced by fractional power of operator A and adopt the arguments on fractional powers of operators. We study the approximate controllability for Eq. 1 in the original space X.

The obtained results have more general applications in subspace $X_{1+\epsilon}$ and as a result they are still valid for the PDE systems with the nonlinear terms involving spatial derivatives. Clearly, the obtained results in this paper extend straight to the works in [38, 16, 26] and develop the corresponding results in [24, 25].

We recall some concepts, hypotheses, and basic results about resolvent operator and facts to be used. We focus our attention on the existence of mild solutions for system (1), we discuss the approximate controllability for this system and obtain our main results. An example is provided to illustrate the applications of the approximate controllability theorem (see [1]).

2 Preliminaries

For$X$ be a Hilbert space and the operator $-A: D(A)\subseteq X\to X$ be the infinitesimal generator of a compact analytic semigroup $\left(S(1+\epsilon)\right)_{\epsilon\ge -1}$. Y is the Banach space formed from $D(A)$ with the graph norm $\|y_r\|_Y=\|Ay_r\|+\|y_r\|$, for$y_r\in D(A)$. Let $0\in\rho(A)$, the resolvent set of operator A, for $-1<\epsilon<0$, we can define the fractional power $A^{1+\epsilon}$, as a closed linear operator on its domain $D(A^{1+\epsilon})$. Furthermore, the subspace $D(A^{1+\epsilon})$ is dense in X and the expression

$$\|x_r\|_{1+\epsilon}=\|A^{1+\epsilon}x_r\|, \qquad x_r\in D(A^{1+\epsilon}),$$

defines a norm on $D(A^{1+\epsilon})$. Denote the space $(D(A^{1+\epsilon}), \|\cdot\|_{1+\epsilon})$ by $X_{1+\epsilon}$, then it is well known that for each $-1 < \epsilon < 0, X_{1+\epsilon}$ is a Banach space. Moreover, $X_{1+2\epsilon} \hookrightarrow X_{1+\epsilon}$ for $-1 < \epsilon < 0$and the imbedding is compact whenever $R(\lambda, A)$, the resolvent operator of A, is compact. Hereafter, we denote by $C([0, 1+2\epsilon], X_{1+2\epsilon})$ the Banach space of continuous functions from $[0, 1+2\epsilon]$ to $X_{1+2\epsilon}$ with the norm:

$$\|x_r\|_C = \sup_{\epsilon \geq -1} \|A^{1+2\epsilon} x_r(1+\epsilon)\|, \qquad x_r \in C([0, 1+2\epsilon], X_{1+2\epsilon}).$$

For the theory of operator semi-group, see [39] and [40].

The theory of resolvent operator plays an essential role in investigating the existence of solutions of Eq. 1. We collect the definition and some basic results about this theory see [2–3].

Definition 2.1 (see [2]) A family of bounded linear operators $W(1+\epsilon) \in \mathscr{L}(X)$ for $\epsilon \geq -1$ is called resolvent operators for:

$$\begin{cases} \dfrac{d}{d(1+\epsilon)} x_r(1+\epsilon) = -A x_r(1+\epsilon) + \displaystyle\int_0^{1+\epsilon} \gamma(1+\epsilon-s) x_r(s) ds, \qquad \epsilon \geq 0, \\ x_r(0) = (x_r)_0 \in X, \end{cases} \tag{6}$$

if

(i) $W(0) = I$ and $\|W(1+\epsilon)\| \leq N_1 e^{\omega(1+\epsilon)}$ for some $N_1 > 0, \omega \in \mathbb{R}$.

(ii) For all $x_r \in X, W(1+\epsilon)x_r$ is continuous for $\epsilon \geq -1$.

(iii)$W(1+\epsilon) \in \mathcal{L}(Y)$, for $\epsilon \geq -1$. For $x_r \in Y$, $W(1+\epsilon)x_r \in C^1([0, 1+2\epsilon], X) \cap C([0, 1+2\epsilon], Y)$ and for $\epsilon \geq -1$ such that

$$W'(1+\epsilon)x_r = -AW(1+\epsilon)x_r + \int_0^{1+\epsilon} \gamma(1+\epsilon-s) W(s) x_r ds$$
$$= -W(1+\epsilon)Ax_r + \int_0^{1+\epsilon} W(1+\epsilon-s)\gamma(s) x_r ds.$$

Suppose that A and $\gamma(\cdot)$ in Eq. (6) satisfy the hypotheses (V_1)– (V_3) in [20]. Then, it follows from [3] that, under these conditions, there is a family of resolvent operator $\big(W(1+\epsilon)\big)_{\epsilon \geq -1}$ for the linear Eq (6) defined by

$$W(0) = I$$

And

$$W(1+\epsilon)x_r = \frac{1}{2\pi i}\int_{\Gamma} e^{\lambda(1+\epsilon)}\left(\lambda I - A - \gamma^*(\lambda)\right)^{-1} x_r d\lambda = \frac{1}{2\pi i}\int_{\Gamma} e^{\lambda(1+\epsilon)}\rho(\lambda)x_r d\lambda, \qquad \epsilon \geq 0,$$

WhereΓ is a contour of the type used to obtain an analytic semigroup and $\gamma^*(\lambda)$ denotes the Laplace transform of $\gamma(1+\epsilon)$. We can select contour to be included in the region

$\Lambda = \left\{\lambda \in C: |\arg\lambda| < \frac{\pi}{2} + \delta, 0 < \delta < \frac{\pi}{2}\right\}$, consisting of Γ_1, Γ_2, and Γ_3, where

$$\Gamma_1 = \left\{re^{i\phi}: r \geq 1\right\}, \qquad \Gamma_3 = \left\{re^{-i\phi}: r \geq 1\right\}, \qquad \frac{\pi}{2} < \phi < \frac{\pi}{2} + \delta,$$

$$\Gamma_2 = \left\{e^{i\theta}: -\phi \leq \theta \leq \phi\right\},$$

oriented so that $Im(\lambda)$ is increasing on Γ_1 and Γ_2. Moreover, $W(1+\epsilon)$ is also analytic and there exist $N, C_{1+\epsilon} > 0$ such that:

$$\|W(1+\epsilon)\| \leq N \quad \text{and} \quad \|A^{1+\epsilon}W(1+\epsilon)\| \leq \frac{C_{1+\epsilon}}{(1+\epsilon)_{1+\epsilon}}, \qquad -1 \leq \epsilon < 0. \quad (7)$$

For the resolvent operator $W(1+\epsilon)$, we have:

Lemma 2.1 (see [31, 32]) $W(1+\epsilon)$ and $AW(1+\epsilon)$ are both continuous for $\epsilon \geq 0$ in the uniform operator topology of (X).

We will also assume that:

$$A^{1+\epsilon}W(1+\epsilon)x_r = W(1+\epsilon)A^{1+\epsilon}x_r, \qquad \text{for any} \quad -1 < \epsilon < 0, \qquad x_r \in D(A^{1+\epsilon}). \qquad (8)$$

It is easy to see that this commutation is not always valid. We point out, however, that this property can be reached in many cases. For example, let $\gamma(1+\epsilon-s) = b(1+\epsilon-s)A$ with b(t) a scalar function defined on $(0, +\infty)$, then the linear Eq (6) becomes:

$$\begin{cases} \dfrac{d}{d(1+\epsilon)}x_r(1+\epsilon) = -Ax_r(1+\epsilon) + \displaystyle\int_0^{1+\epsilon} b(1+\epsilon-s)Ax_r(s)ds, \\ x_r(0) = (x_r)_0 \in X. \end{cases} \qquad (9)$$

If we impose the following conditions on the equation equation (9),

(V_1') A generates an analytic semi-group on X. In particular,

$$\Lambda 1 = \left\{\lambda \in \mathbb{C}: |\arg\lambda| < \left(\frac{\pi}{2}\right) + \delta_1\right\}, 0 < \delta_1 < \pi/2$$

is contained in the resolvent set of A and $\|(\lambda I - A)^{-1}\| \leq M/|\lambda|$ on Λ_1 for some constant $M > 0$. The scalar function $b(\cdot)$ is in $L^1(0,\infty)$ with $b^*(\lambda)$ absolutely convergent for $Re\lambda > 0$, where $b^*(\lambda)$ denotes the Laplace transform of $b(1+\epsilon)$.

(V_2') There exists $\Lambda = \left\{\lambda \in \mathbb{C}: |\arg\lambda| < \left(\frac{\pi}{2}\right) + \delta_2\right\}, 0 < \delta_2 < \pi/2$, so that $\lambda \in \Lambda$ implies $\psi(\lambda) = 1 + b^*(\lambda)$ exists and is not zero. Further, $\lambda\psi^{-1}(\lambda) \in \Lambda_1$ for $\lambda \in \Lambda$.

$(V_3')Ir\ \Lambda, b^*(\lambda) \to 0$ as $|\lambda| \to \infty$.

Then, from [3], the conditions (V_1)–(V_3) there are fulfilled and hence the resolvent operator $W(1+\epsilon)$ is analytic. It is easy to see that Eq. 8 holds in this situation.

We define the mild solutions of Eq. 1 expressed by the resolvent operator $W(1+\epsilon)$ as follows (see [1]).

Definition 2.2 A function $x_r(\cdot) \in C([0, 1+2\epsilon], X_{1+\epsilon})$ is said to be a mild solution of Eq. 1 if:

$$x_r(1+\epsilon) = W(1+\epsilon)\left[(x_r)_0 + F\left(0, x_r\left(h_1(0)\right)\right) - g(x_r)\right] - F\left(1+\epsilon, x_r\left(h_1(1+\epsilon)\right)\right)$$
$$+ \int_0^{1+\epsilon} AW(1+\epsilon-s)F\left(s, x_r\left(h_1(s)\right)\right)ds$$
$$- \int_0^{1+\epsilon} W(1+\epsilon-s)\int_0^s \gamma(s-\tau)F\left(\tau, x_r\left(h_1(\tau)\right)\right)d\tau\, ds$$
$$+ \int_0^{1+\epsilon} W(1+\epsilon-s)\left(G\left(s, x_r\left(h_2(s)\right)\right) + Bu(s)\right)ds,$$

for $\epsilon \geq -1$.

We give present the concepts of approximate controllability.

Definition 2.3 equation (1) is said to be approximately controllable on the interval $I = [0, 1+2\epsilon]$ if $\mathcal{R}(1+2\epsilon, (x_r)_0)$ is dense in X, i.e.:

$$\overline{\mathcal{R}(1+2\epsilon, (x_r)_0)} = X,$$

where $\mathcal{R}(1+2\epsilon, (x_r)_0) = \{x_r(1+2\epsilon, (x_r)_0, u), u(\cdot) \in L^2(I;U)\}$.

As mentioned in Section 1, we shall discuss the approximate controllability for system (1) by applying the so-called resolvent condition introduced in [21]. For this, we need to define the following operators.

$$\Gamma_{1+2\epsilon} = \Gamma \int_0^{1+2\epsilon} W(1+2\epsilon-s)BB^*W^*(1+2\epsilon-s)ds,$$

$$R(\lambda, \Gamma_{1+2\epsilon}) = (\lambda I + \Gamma_{1+2\epsilon})^{-1},$$

where B^* and $W^*(1+\epsilon)$ denote the adjoints of the operators B and $W(1+\epsilon)$, respectively. Since $\Gamma_{1+2\epsilon}: X \to X$ is clearly positive, we see $R(\lambda, \Gamma_{1+2\epsilon})$ is well defined on X. In the sequel, we always assume that the operator $R(\lambda, \Gamma_{1+2\epsilon})$ satisfies that:

(H_0) $\lambda R(\lambda, g_{1+2\epsilon}) \to 0$ as $\lambda \to 0^+$ in the strong operator topology.

It is not difficult to prove by using the similar arguments as in [21] that:

Theorem 2.1 Hypothesis (H_0) holds if and only if the linear control system corresponding to system (1):

$$\begin{cases} \dfrac{d}{d(1+\epsilon)} x_r(1+\epsilon) = -Ax_r(1+\epsilon) + \displaystyle\int_0^{1+\epsilon} \gamma(1+\epsilon-s)x_r(s)ds + Bu(1+\epsilon), & \epsilon \geq -1, \\ x_r(0) = (x_r)_0, \end{cases}$$

is approximately controllable on $[0, 1+2\epsilon]$.

We end this section by stating the following fixed point principle.

Theorem 2.2 (see [41]) Assume that P is a condensing operator on a Banach space X, i.e., P is continuous and takes bounded sets into bounded sets, and $(1+\epsilon)\big(P(B)\big) \leq (1+\epsilon)(B)$ for every bounded set B of X with $(1+\epsilon)(B) > 0$. If $P(H) \subseteq H$ for a convex, closed, and bounded set H of X, then P has a fixed point in H (where $(1+\epsilon)(\cdot)$ denotes the Kuratowski measure of noncompactness).

3 Approximate Controllability

We study the approximate controllability of System (1). We first prove the existence of solutions of System (1). We then show that under certain assumptions, the approximate controllability of Eq. 1 is implied by the approximate controllability of the corresponding linear system. That is, for any $x_r^{1+2\epsilon} \in X$, by choosing proper control u^λ (for any given $\lambda \in (0,1)$), we show there is a mild solution

$x_r^\lambda(0, (x_r)_0, u) \in C([0, 1+2\epsilon];\ X^{1+\epsilon})$ of System (1), then we use (H_0) to prove that

$x_r^\lambda(1+2\epsilon) \to x_r^{1+2\epsilon}$ in X as $\lambda \to 0^+$ which means that Eq. 1 is approximately controllable on

$[0, 1+2\epsilon]$.

To follow, we make the following restrictions on Eq. 1. Let $-1 < \epsilon < 0$.

$(H_1) W(1+\epsilon)$ is a compact operator for each $\epsilon \geq 0$.

$(H_2) B \in \mathfrak{L}(U; X)$, i.e., B is a bounded linear operator from U to X. Let $\|B\| = M$.

(H_3) There exists a constant $-1 < \epsilon < 0$, such that $F: [0, 1+2\epsilon] \times X_{1+2\epsilon} \to X_{2+3\epsilon}$ satisfies the Lipschitz condition, i.e., there exists a constant $\epsilon \geq 0$ such that:

$$\|F(1+\epsilon, (x_r)_1) - F(1+2\epsilon, (x_r)_2)\|_{2+3\epsilon} \leq (1+\epsilon)(|\epsilon| + \|(x_r)_1 - (x_r)_2\|_{1+2\epsilon})$$

for any $\epsilon \geq -1, (x_r)_1, (x_r)_2 \in X_{1+2\epsilon}$, and the inequality

$$\|F(1+\epsilon, x_r)\|_{2+3\epsilon} \leq (1+\epsilon)(\|x_r\|_{1+2\epsilon} + 1)$$

holds for any $(1+\epsilon, x_r) \in [0, 1+3\epsilon] \times X_{1+2\epsilon}$.

$(H_4) \{\gamma(1+\epsilon)\}_{\epsilon \geq -1}$ is a family of operators from Y to X such that $\gamma(1+\epsilon) \in \mathscr{L}(X_{2+3\epsilon}, X)$ for each $\epsilon \geq -1$. Then, there exists a positive number M_1 such that:

$$\|\gamma(1+\epsilon)\|_{2+3\epsilon}, \qquad 0 \leq M_1, \qquad \epsilon \geq -1.$$

(H_5) The function $G: [0, 1+3\epsilon] \times X_{1+2\epsilon} \to X$ verifies the following conditions:

(i) For each $\epsilon \geq -1$, the function $G(1+\epsilon, \cdot): X_{1+2\epsilon} \to X$ is continuous and for each $x_r \in X_{1+2\epsilon}$ the function $G(\cdot, x_r): [0, 1+2\epsilon] \to X$ is strongly measurable;

(ii) For each positive number $k \in \mathbb{N}$, there is a positive function $g_k \in L^{\infty}([0, 1+2\epsilon])$ such that:

$$\sup_{x_r \leq k} \|G(1+\epsilon, x_r)\| \leq g_k(1+\epsilon).$$

$(H_6) h_i \in C([0, 1+2\epsilon]; [0, 1+2\epsilon]), i = 1, 2$. And the function $g: C([0, 1+2\epsilon], X_{1+2\epsilon}) \to X_{1+2\epsilon}$ is a continuous mapping which maps bounded sets into bounded sets, i.e., there exists a constant $\epsilon \geq 0$ such that for any $x_r \in C([0, 1+2\epsilon], X_{1+2\epsilon})$,

$$\|g(x_r)\|_{1+2\epsilon} \leq (1+\epsilon)\|x_r\|_C.$$

Moreover, there is a $s + \epsilon = \delta(k) \in (0, s+2\epsilon)$ such that $g(x_r) = g(y_r)$ for any $x_r, y_r \in B_k$ with $x_r(s) = y_r(s), \epsilon \geq 0$, where $B_k = \{x_r \in C([0, s+2\epsilon], X_{1+2\epsilon}), \|x_r(\cdot)\|_C \leq k\}$.

For any given $x_r^{1+2\epsilon} \in X, \lambda \in (0, 1)$ and for any $x_r(\cdot) \in C([0, 1+2\epsilon], X_{1+2\epsilon})$, we take the control function $u^{\lambda}(1+\epsilon)$, simply denoted by $u(1+\epsilon)$ as:

$$u(1+\epsilon) = B^*W^*(\epsilon)R(\lambda,\Gamma_{1+2\epsilon})\Big[x_r^{1+2\epsilon} - W(1+2\epsilon)\Big((x_r)_0 + F\Big(0, x_r\big(h_1(0)\big)\Big) - g(x_r)\Big)$$
$$+ F\Big(1+2\epsilon, x_r\big(h_1(1+2\epsilon)\big)\Big) - \int_0^{1+2\epsilon} AW\,(1+2\epsilon-s)F\Big(s, x_r\big(h_1(s)\big)\Big)\,ds$$
$$+ \int_0^{1+2\epsilon} W(1+2\epsilon-s)\int_0^s \gamma(s-\tau)F\Big(\tau, x_{rr}\big(h_1(\tau)\big)\Big)\,d\tau\;ds$$
$$- \int_0^{1+2\epsilon} W(1+2\epsilon$$
$$- s)G\Big(s, x_r\big(h_2(s)\big)\Big)\,ds\Big]. \qquad (10)$$

Using this control, we define the operator Q^λ on $C([0,1+2\epsilon];\ X_{1+2\epsilon})$ as, for $\epsilon \geq -1$:

$$\big(Q^\lambda x_r\big)(1+\epsilon)$$
$$= W(1+\epsilon)\Big((x_r)_0 + F\Big(0, x_r\big(h_1(0)\big)\Big) - g(x_r)\Big) - F\Big(1+\epsilon, x_r\big(h_1(1+\epsilon)\big)\Big)$$
$$+ \int_0^{1+\epsilon} AW\,(1+\epsilon-s)F\Big(s, x_r\big(h_1(s)\big)\Big)\,ds$$
$$- \int_0^{1+\epsilon} W(1+\epsilon-s)\int_0^s \gamma(s-\tau)F\Big(\tau, x_r\big(h_1(\tau)\big)\Big)\,d\tau\,ds$$
$$+ \int_0^{1+\epsilon} W(1+\epsilon-s)\Big(G\Big(s, \big(h_2(s)\big)\Big) + Bu(s)\Big)\,ds.$$

We now establish the existence result firstly (see [1]).

Theorem 3.1 Assume that the assumptions (H_0)– (H_6) are satisfied. Then, the equation (1) has at least one mild solution on $[0, 1+2\epsilon]$ provided that:

$$K_0 := \Big[(N+1)\big\|A^{-(1+\epsilon)}\big\| + \frac{(1+2\epsilon)^{1+\epsilon}C_{-\epsilon}}{1+\epsilon} - \frac{(1+2\epsilon)^{-2\epsilon}C_{1+2\epsilon}M_1}{2\epsilon} + \frac{(1+2\epsilon)^{-2\epsilon}C_{1+2\epsilon}M^2N}{\lambda(-2\epsilon)}$$
$$\times\left((N+1)\big\|A^{-(2+3\epsilon)}\big\| + \frac{C_{-(1+3\epsilon)}(1+2\epsilon)^{2+3\epsilon}}{2+3\epsilon} + NM_1(1+2\epsilon)^2\right)\Big](1+\epsilon) + N^2$$
$$+ \frac{(1+2\epsilon)^{-2\epsilon}C_{1+2\epsilon}M^2N}{\lambda(-2\epsilon)}\big\|A^{-(1+2\epsilon)}\big\|_{1+\epsilon} < 1. \qquad (11)$$

As we pointed out in Section 1, because the function g does not satisfy the Lipschitz or compactness condition, we can not prove this theorem by directly applying Theorem 2.2. Hence, we will show this

result by using the approximation arguments. For this purpose, we establish two auxiliary lemmas. For a fixed $r \in \mathbb{N}$, let us consider the following approximate problem:

$$\begin{cases} \dfrac{d}{d(1+\epsilon)}\left[x_r(1+\epsilon) + F\left(1+\epsilon, x_r\left(h_1(1+\epsilon)\right)\right)\right] \\ = -Ax_r(1+\epsilon) + 1 + \epsilon\displaystyle\int_{\gamma}^{0} (1+\epsilon-s)x_r(s)ds + G\left(1+\epsilon, x_r\left(h_2(1+\epsilon)\right)\right) + Bu(1+\epsilon), \\ \epsilon \geq -1, \qquad x_r(0) + W\left(\dfrac{1}{n}\right)g(x_r) = (x_r)_0 \end{cases} \tag{12}$$

Then, we have the following result (see [1]).

Lemma 3.1 Assume that all the conditions in Theorem 3.1 are satisfied, then for any $n \in \mathbb{N}$, the nonlocal Cauchy equation (12) has at least one mild solution $x_r(\cdot) \in C([0, 1+2\epsilon], X_{1+2\epsilon})$.

Proof. Let B_k be that defined in (H_6). It is obvious that B_k is a bounded, closed, and convex set in $C([0, 1+2\epsilon], X_{1+2\epsilon})$. In view of Eq. 10, we estimate the norm of the control function corresponding to the equation (12), that is,

$$\begin{aligned} \|u_n(s)\| = \Bigg\| & B^*W^*(1+2\epsilon-s)R(\lambda, \Gamma_{1+2\epsilon})\Bigg[x_r^{1+2\epsilon} \\ & - W(1+2\epsilon)\left((x_r)_0 + F\left(0, x_r\left(h_1(0)\right)\right) - W\left(\frac{1}{n}\right)g(x_r)\right) \\ & + F\left(1+2\epsilon, x_r\left(h_1(1+2\epsilon)\right)\right) - \int_0^{1+2\epsilon} AW(1+2\epsilon-s)F\left(s, x_r\left(h_1(s)\right)\right)ds \\ & + \int_0^{1+2\epsilon} W(1+2\epsilon-s)\int_0^{s} \gamma(s-\tau)F\left(\tau, x_r\left(h_1(\tau)\right)\right)d\tau\, ds \\ & - \int_0^{1+2\epsilon} W(1+2\epsilon-s)G\left(s, x_r\left(h_2(s)\right)\right)ds\Bigg]\Bigg\| \end{aligned}$$

$$= \left\| B^* W^*(\epsilon) R(\lambda, \Gamma_{1+2\epsilon}) \left[x_r^{1+2\epsilon} \right.\right.$$

$$- W(1+2\epsilon)\left((x_r)_0 + A^{-(2+3\epsilon)A^{2+3\epsilon}F\left(0, x_r(h_1(0))\right)} - A^{-(1+2\epsilon)} W\left(\frac{1}{n}\right) A^{1+2\epsilon} g(x_r) \right)$$

$$+ A^{-(2+3\epsilon)} A^{2+3\epsilon} F\left(1+2\epsilon, x_r(h_1(1+2\epsilon))\right)$$

$$- \int_0^{1+2\epsilon} A^{-(1+3\epsilon)} W(1+2\epsilon-s) A^{2+3\epsilon} F\left(s, x_r(h_1(s))\right) ds$$

$$+ \int_0^{1+2\epsilon} W(1+2\epsilon-s) \int_0^s \gamma(s-\tau) F\left(\tau, x_r(h_1(\tau))\right) d\tau ds$$

$$\left.\left. - \int_0^{1+2\epsilon} W(1+2\epsilon-s) G\left(s, x_r(h_2(s))\right) ds \right] \right\|$$

$$\leq MN \frac{1}{\lambda} \left[\|x_r^{1+2\epsilon}\| + N\left(\|(x_r)_0\| + \left\|A^{-(2+3\epsilon)}\right\|(1+\epsilon)(k+1) + \left\|A^{-(1+2\epsilon)}\right\| N(1+\epsilon)k \right) \right.$$

$$+ \left\|A^{-(2+3\epsilon)}\right\|(1+\epsilon)(k+1) + \frac{C_{-(1+3\epsilon)}(1+2\epsilon)^{2+3\epsilon}}{2+3\epsilon}(1+\epsilon)(k+1)$$

$$\left. + NM_1(1+2\epsilon)^2(1+\epsilon)(k+1) + N\int_0^{1+2\epsilon} g_k(s) ds \right]$$

$$= MN \frac{1}{\lambda} \left[\|x_r^{1+2\epsilon}\| + N\|(x_r)_0\| + \left((N+1)\left\|A^{-(2+3\epsilon)}\right\| + \frac{C_{-(1+3\epsilon)}(1+2\epsilon)^{2+3\epsilon}}{2+3\epsilon} + NM_1(1+2\epsilon)^2 \right)(1 \right.$$

$$+ \epsilon)(k+1)\left\|A^{-(1+2\epsilon)}\right\| N^2(1+\epsilon)k + N(1$$

$$\left. + 2\epsilon)\, \|g_k(\cdot)\|_\infty \right]. \qquad (13)$$

Here, due to (H_0), we have used the fact w. l. o. g. that

$$\|R(\lambda, \Gamma_{1+2\epsilon})\| \leq \frac{1}{\lambda}, \qquad \text{for all} \quad \lambda \in (0,1).$$

Define now the operator Q_n on $C([0, 1+2\epsilon], X_{1+2\epsilon})$ by the formula:

$$
\begin{aligned}
&(Q_n x_r)(1+\epsilon)\\
&\quad = W(1+\epsilon)\left((x_r)_0 + F\left(0, x_r\left(h_1(0)\right)\right) - W\left(\frac{1}{n}\right) g(x_r)\right) - F\left(1+\epsilon, x_r\left(h_1(1+\epsilon)\right)\right)\\
&\quad + \int_0^{1+\epsilon} AW(1+\epsilon-s) F\left(s, x_r\left(h_1(s)\right)\right) ds\\
&\quad - \int_0^{1+\epsilon} W(1+\epsilon-s) \int_0^s \gamma(s-\tau) F\left(\tau, x_r\left(h_1(\tau)\right)\right) d\tau\, ds\\
&\quad + \int_0^{1+\epsilon} W(1+\epsilon-s)\left(G\left(s, x_r\left(h_2(s)\right)\right) + Bu_n(s)\right) ds.
\end{aligned}
$$

Then, it is easy to see that a fixed point of Q_n is exactly a mild solution of Eq. 12. Subsequently, we will prove that Q_n has a fixed point on some B_k by applying Theorem 2.2.

We first claim that there exists $a\ k \in \mathbb{N}$ such that $Q_n(B_k) \subseteq B_k$, if it is not true, then for each $k \in \mathbb{N}$, there is a function $(x_r)_k(\cdot) \in B_k$, but $Q_n(x_r)_k \notin B_k$, that is $\|Q_n(x_r)_k(1+\epsilon)\|_{1+2\epsilon} > k$ for some

$t(k) \in [0, 1+2\epsilon]$, where $t(k)$ denotes t is dependent on k. On the other hand, however, we have by virtue of Eqs. 7 and 13 that:

$$
\begin{aligned}
k &< \|(Q_n(x_r)_k)(1+\epsilon)\|_{1+2\epsilon}\\
&\le \left\|W(1+\epsilon)\left[(x_r)_0 + F\left(0, (x_r)_k\left(h_1(0)\right)\right) - W\left(\frac{1}{n}\right) g((x_r)_k)\right]\right\|_{1+2\epsilon}\\
&\quad + \left\|F\left(1+\epsilon, (x_r)_k\left(h_1(1+\epsilon)\right)\right)\right\|_{1+2\epsilon}\\
&\quad + \int_0^{1+\epsilon} \left\|A^{-\epsilon} W(1+\epsilon-s) A^{1+\epsilon} F\left(s, (x_r)_k\left(h_1(s)\right)\right)\right\|_{1+2\epsilon} ds\\
&\quad + \int_0^{1+\epsilon} \|A^{1+2\epsilon} W(1+\epsilon-s)\| \int_0^s \left\|\gamma(s-\tau) F\left(\tau, x_r\left(h_1(\tau)\right)\right)\right\| d\tau ds\\
&\quad + \int_0^{1+\epsilon} A^{1+2\epsilon} W(1+\epsilon-s) G\left(s, x_r\left(h_2(s)\right)\right) ds\\
&\quad + \int_0^{1+\epsilon} \|A^{1+2\epsilon} W(1+\epsilon-s) B u_n(s)\| ds
\end{aligned}
$$

$$
\begin{aligned}
&\le N\left[\|(x_r)_0\|_{1+2\epsilon} + \left\|A^{-(1+\epsilon)}\right\|(1+\epsilon)(k+1) + N(1+\epsilon)k\right] + \left\|A^{-(1+\epsilon)}\right\|(1+\epsilon)(k+1)\\
&\quad + \frac{(1+2\epsilon)^{1+\epsilon} C_{-\epsilon}}{1+\epsilon}(1+\epsilon)(k+1) - \frac{(1+2\epsilon)^{1-2\epsilon} C_{1+2\epsilon} M_1}{2\epsilon}(1+\epsilon)(k+1)\\
&\quad - \frac{(1+2\epsilon)^{-2\epsilon} C_{1+2\epsilon}}{2\epsilon} \|g_k(\cdot)\|_\infty
\end{aligned}
$$

$$+\frac{(1+2\epsilon)^{-2\epsilon}C_{1+2\epsilon}M_2N}{\lambda(-2\epsilon)}[\|x_r^{1+2\epsilon}\|+N\|(x_r)_0\|$$
$$+\left((N+1)\left\|A^{-(2+3\epsilon)}\right\|+\frac{C_{1-(2+3\epsilon)}(1+2\epsilon)^{2+3\epsilon}}{2+3\epsilon}+NM_1(1+2\epsilon)^2\right)(1+\epsilon)(k+1)$$
$$+\left\|A^{-(1+2\epsilon)}\right\|N^2(1+\epsilon)k+N(1+2\epsilon)\|g_k(\cdot)\|_\infty.$$

Thus, dividing on both sides by the k and taking the lower limit as $k\to+\infty$, we then get:

$$\left[(N+1)\left\|A^{-(1+\epsilon)}\right\|+\frac{(1+2\epsilon)^{1+\epsilon}C_{-\epsilon}}{1+\epsilon}-\frac{(1+2\epsilon)^{1-2\epsilon}C_{1+2\epsilon}M_1}{2\epsilon}+\frac{(1+2\epsilon)^{-2\epsilon}C_{1+2\epsilon}M^2N}{\lambda(-2\epsilon)}\right.$$
$$\left.\times\left((N+1)\left\|A^{-(2+3\epsilon)}\right\|+\frac{C_{1-(2+3\epsilon)}(1+2\epsilon)^{2+3\epsilon}}{2+3\epsilon}+NM_1(1+2\epsilon)^2\right)\right](1+\epsilon)$$
$$+N^2\left(1+\frac{(1+2\epsilon)^{-2\epsilon}C_{1+2\epsilon}M^2N}{\lambda(-2\epsilon)}\left\|A^{-(1+2\epsilon)}\right\|\right),\qquad \epsilon\geq 0,$$

which contradicts (11). Hence, there is a positive integer k such that $Q_n(B_k)\subseteq B_k$.

We then decompose Q_n into two operators Q_{n1}, Q_{n2} on B_k as:

$$(Q_{n1}x_r)(1+\epsilon)$$
$$=W(1+\epsilon)F\left(0,x_r\left(h_1(0)\right)\right)-F\left(1+\epsilon,x_r\left(h_1(1+\epsilon)\right)\right)$$
$$+\int_0^{1+\epsilon}AW(1+\epsilon-s)F\left(s,x_r\left(h_1(s)\right)\right)ds,$$

$$(Q_{n2}x_r)(1+\epsilon)$$
$$=W(1+\epsilon)\left[(x_r)_0-W\left(\frac{1}{n}\right)g(x_r)\right]$$
$$-\int_0^{1+\epsilon}W(1+\epsilon-s)\int_0^s\gamma(s-\tau)F\left(\tau,x_r\left(h_1(\tau)\right)\right)d\tau\,ds$$
$$+\int_0^{1+\epsilon}W(1+\epsilon-s)\left(G\left(s,x_r\left(h_2(s)\right)\right)+Bu_n(s)\right)ds,$$

for all $\epsilon\geq -1$. Next, we will verify that Q_{n1} is a contraction while Q_{n2} is a compact operator.

To prove that Q_{n1} is a contraction, we take $(x_r)_1, (x_r)_2\in B_k$, then, for each $\epsilon\geq -1$, we find:

$$\|(Q_{n1}(x_r)_1)(1+\epsilon)-(Q_{n1}(x_r)_2)(1+\epsilon)\|_{1+2\epsilon}$$
$$\leq \left\|W(1+\epsilon)A^{-(1+\epsilon)}\left[A^{1+\epsilon}F\left(0,(x_r)_1(h_1(0))\right)-A^{1+\epsilon}F\left(0,(x_r)_2(h_1(0))\right)\right]\right\|_{1+2\epsilon}$$
$$+\|A^{-(1+\epsilon)}\|A^{1+\epsilon}F\left(1+\epsilon,(x_r)_1(h_1(1+\epsilon))\right)$$
$$-\left\|A^{1+\epsilon}F\left(1+\epsilon,(x_r)_2(h_1(1+\epsilon))\right)\right\|_{1+2\epsilon}$$
$$+\left\|\int_0^{1+\epsilon} A^{-\epsilon}W(1+\epsilon-s)A^{1+\epsilon}\left[F\left(s,(x_r)_1(h_1(s))\right)\right.\right.$$
$$\left.\left.-F\left(s,(x_r)_2(h_1(s))\right)\right]ds\right\|_{1+2\epsilon}$$
$$\leq N\|A^{-(1+\epsilon)}\|(1+\epsilon)\sup_{\epsilon\geq -1}\|(x_r)_1(1+\epsilon)-(x_r)_2(1+\epsilon)\|_{1+2\epsilon}+\|A^{-(1+\epsilon)}\|(1$$
$$+\epsilon)\sup_{\epsilon\geq -1}\|(x_r)_1(1+\epsilon)-(x_r)_2(1+\epsilon)\|_{1+2\epsilon}$$
$$+\int_0^{1+\epsilon}\frac{C_{-\epsilon}(1+\epsilon)}{(1+\epsilon-s)^{-\epsilon}}\|(x_r)_1(s)-(x_r)_2(s)\|_{1+2\epsilon}ds$$
$$\leq\left((N+1)A^{-(1+\epsilon)}+\frac{(1+2\epsilon)^{1+\epsilon}C_{-\epsilon}}{1+\epsilon}\right)(1$$
$$+\epsilon)\sup_{\epsilon\geq -1}\|(x_r)_1(1+\epsilon)-(x_r)_2(1+\epsilon)\|_{1+2\epsilon}.$$

Thus, we obtain

$$\|(Q_{n1}(x_r)_1)-(Q_{n1}(x_r)_2)\|_C\leq\left(NM_0+M_0+\frac{C_{-\epsilon}(1+2\epsilon)^{1+\epsilon}}{1+\epsilon}\right)(1+\epsilon)\|(x_r)_1-(x_r)_2\|_C,$$

which by assumptions (11) implies Q_{n1} is a contraction.

We now show that Q_{n2} is compact. To see this, we first prove that Q_{n2} is continuous on B_k. In fact, for $\{(x_r)_m\}\subseteq B_k$ with $(x_r)_m\to x_r$ in B_k, combining (H_5) and (H_6), we see that:

$$g((x_r)_m)\to g(x_r)\text{and}\quad G\left(s,(x_r)_m(h_2(s))\right)\to G\left(s,x_r(h_2(s))\right),\qquad m\to+\infty.$$

Since

$$\left\|G\left(s,(x_r)_m(h_2(s))\right)-G\left(s,x_r(h_2(s))\right)\right\|_{1+2\epsilon}\leq 2g_k(s),$$

we deduce from the dominated convergence theorem and the strong continuity of $W(1+\epsilon)$ that:

$$\|Q_{n2}(x_r)_m - Q_{n2}x_r\|_{1+2\epsilon}$$
$$\leq \sup_{\epsilon\geq -1} \Big(\Big\|W(1+\epsilon)W\Big(\frac{1}{n}\Big)[g((x_r)_m) - g(x_r)]\Big\|_{1+2\epsilon}$$
$$+ \Big\|\int_0^{1+\epsilon} W(1+\epsilon-s)\int_0^s \gamma(s-\tau)\Big[F\Big(\tau,(x_r)_m(h_1(\tau))\Big)$$
$$- F\Big(\tau,x_r(h_1(\tau))\Big)\Big]d\tau ds\Big\|_{1+2\epsilon}$$
$$+ \Big\|\int_0^{1+\epsilon} W(1+\epsilon-s)\Big[G\Big(s,(x_r)_m(h_2(s))\Big) - G\Big(s,x_r(h_2(s))\Big)\Big]ds\Big\|_{1+2\epsilon}$$
$$+ \Big\|\int_0^{1+\epsilon} W(1+\epsilon-s)\big[B\big(u_m(s)-u(s)\big)\big]ds\Big\|_{1+2\epsilon} \to 0 \quad as \quad m\to\infty,$$

i.e., Q_{n2} is continuous on B_k.

We then verify that $\{(Q_{n2}x_r)(\cdot), x_r \in B_k\} \subseteq C([0,1+2\epsilon], X_{1+2\epsilon})$ is a family of equicontinuous function. Indeed, let $\epsilon > 0$ be small enough, then:

$$\|(Q_{n2}x_r)(1+2\epsilon) - (Q_{n2}x_r)(1+\epsilon)\|_{1+2\epsilon}$$
$$\leq \|W(1+2\epsilon) - W(1+\epsilon)\|[\|(x_r)_0\|_{1+2\epsilon} + N(1+\epsilon)k]$$
$$+ \|A^{2\epsilon}\|(M_1(1+3\epsilon)\,(1+\epsilon)(k+1) + M\|u_n\| + \|g_k(\cdot)\|_\infty)\int_0^1 \|AW(1+2\epsilon-s)$$
$$- AW(1+\epsilon-s)\|ds$$
$$+ (M_1(1+3\epsilon)\,(1+\epsilon)(k+1) + M\|u_n\| + \|g_k(\cdot)\|_\infty)\int_1^{1+\epsilon} \Big(\frac{C_{1+2\epsilon}}{(1+2\epsilon-s)^{1+2\epsilon}}$$
$$+ \frac{C_{1+2\epsilon}}{(1+\epsilon-s)^{1+2\epsilon}}\Big)ds$$

$$+(M_1(1+3\epsilon)(1+\epsilon)(k+1) + M\|u_n\| + \|g_k(\cdot)\|_\infty)\int_{1+\epsilon}^{1+2\epsilon} \frac{C_{1+2\epsilon}}{(1+2\epsilon-s)^{1+2\epsilon}}ds$$
$$\leq W(1+2\epsilon) - W(1+\epsilon)[\|(x_r)_0\|_{1+2\epsilon} + N(1+\epsilon)k]$$
$$+ (M_1(1+3\epsilon)(1+\epsilon)(k+1) + M\|u_n\| + \|g_k(\cdot)\|_\infty)$$
$$\times [\|A^{2\epsilon}\|\int_0^1 \|AW(1+2\epsilon-s) - AW(1+\epsilon-s)\|ds + \frac{C_{1+2\epsilon}}{2\epsilon}(2\epsilon)^{-2\epsilon} + \epsilon^{-2\epsilon}.$$

It is easy to see that, as $\epsilon \to 0$ the right-hand side of the above inequality tends to be zero independently of $x_r \in B_k$, since $\big(W(1+\epsilon)\big)_{\epsilon\geq 0}$ and $\big(A^{1+2\epsilon}W(1+\epsilon)\big)_{\epsilon\geq 0}$ are continuous in t in the uniform operator

topology by Lemma 2.1. Analogously, we can deduce that the functions $\{Q_{n2}x_r, x_r \in B_k\}$ are equicontinuous at $\epsilon = -1$. So, Q_{n2} maps B_K into a family of equicontinuous functions.

Now, we show that for fixed $\epsilon \geq -1$, the set $\{(Q_{n2}x_r)(1+\epsilon), x_r \in B_k\}$ is relatively compact in $X_{1+2\epsilon}$.

If $\epsilon = -1$, then $(Q_{n2}x_r)(0) = (x_r)_0 - W\left(\frac{1}{n}\right)g(x_r)$. As $g((x_r))$ is a bounded set on B_k, from the compactness of $W\left(\frac{1}{n}\right)$ and the closedness of $A^{1+2\epsilon}$, we see readily that the assertion is true for $\epsilon = -1$.

For $\epsilon \geq -1$, let us write $(Q_{n2}x_r)(1+\epsilon) = W(1+\epsilon)\left[(x_r)_0 - W\left(\frac{1}{n}\right)g(x_r)\right] + \left(Q^1_{n^2}x_r\right)(1+\epsilon)$ with

$$
\begin{aligned}
&(Q^1_{n2}x_r)(1+\epsilon) \\
&\qquad = \int_0^{1+\epsilon} W(1+\epsilon-s)\left(G\left(s, x_r\left(h_2(s)\right)\right) + Bu_n(s)\right)ds \\
&\qquad - \int_0^{1+\epsilon} W(1+\epsilon-s)\int_0^s \gamma(s-\tau)F\left(\tau, x_r\left(h_1(\tau)\right)\right)d\tau ds.
\end{aligned}
$$

Then, taking $-1 < \epsilon < 0$, we have the following estimate:

$$
\begin{aligned}
&\|A^{1+2\epsilon}(Q^1_{n2}x_r)(1+\epsilon)\| \\
&\qquad \leq \left\| \int_0^{1+\epsilon} A^{1+2\epsilon}W(1+\epsilon-s)\left(G\left(s, x_r\left(h_2(s)\right)\right) + Bu_n(s)\right)ds \right\| \\
&\qquad + \left\| \int_0^{1+\epsilon} A^{1+2\epsilon}W(1+\epsilon-s)\int_0^s \gamma(s-\tau)F\left(\tau, x_r\left(h_1(\tau)\right)\right)d\tau\, ds \right\| \\
&\qquad \leq -\frac{C_{1+2\epsilon}(1+2\epsilon)^{-2\epsilon}}{2\epsilon}\left(\|g_k(\cdot)\|_\infty + M\|u_n\|\right) \\
&\qquad - \frac{C_{1+2\epsilon}(1+2\epsilon)^{1-2\epsilon}M_1(1+\epsilon)}{2\epsilon}\left(\|x_r\|_{1+\epsilon} + 1\right),
\end{aligned}
$$

which means $\{A^{1+2\epsilon}(Q^1_{n2}x_r)(1+\epsilon), x_r \in B_k\}$ is bounded in X. Hence, we conclude immediately that $(Q^1_{n2}x_r)(1+\epsilon)$ is relatively compact in $X_{1+\epsilon}$ by the compactness of operator $A^{-(1+2\epsilon)}: X \to X_{1+2\epsilon}$, since the imbedding $X_{1+2\epsilon} \hookrightarrow X_{1+\epsilon}$ is compact. Thus, $(Q_{n2}x_r)(1+\epsilon)$ is also relatively compact in $X_{1+\epsilon}$ because $W(1+\epsilon)\left[(x_r)_0 - W\left(\frac{1}{n}\right)g(x_r)\right]$does so. Therefore, from the infinite-dimensional version of the Ascoli–Arzela theorem, Q_{n2} is a completely continuous operator on $C([0, 1+2\epsilon], X_{1+\epsilon})$. Those arguments enable us to conclude that $Q_n = Q_{n1} + Q_{n2}$ is a condensing map on B_k. Consequently, according to Theorem 2.2, Q_n has a fixed point $(x_r)_n(\cdot)$ on B_k, which is a mild solution $(x_r)_n(\cdot)$ of equation (12), and this ends the proof of this lemma.

Now, we introduce the solution sets D and $D(1+\epsilon)$, respectively, as:

$$D = \{(x_r)_n \in C([0,1+2\epsilon], X_{1+\epsilon}) : (x_r)_n = Q_n(x_r)_n, n \geq 1\},$$

$$D(1+\epsilon) = \{(x_r)_n(1+\epsilon) : (x_r)_n \in D, n \geq 1\}, \qquad \epsilon \geq -1.$$

For them, we have that (see [1]):

Lemma 3.2 Assume that all the conditions of Theorem 3.1 are fulfilled. Then, for each $\epsilon \geq -1, D(1+\epsilon)$ is relatively compact in $X_{1+\epsilon}$ and D is equicontinuous on $(0, 1+2\epsilon]$.

Proof. For $n \geq 1, (x_r)_n \in D$ and $\epsilon \geq -1$, we can derive that:

$$\begin{aligned}(x_r)_n(1+\epsilon) = W(1+\epsilon)\left[(x_r)_0 + F\left(0, (x_r)_n\left(h_1(0)\right)\right) - W\left(\frac{1}{n}\right) g((x_r)_n)\right] \\ - F\left(1+\epsilon, (x_r)_n\left(h_1(1+\epsilon)\right)\right) \\ + \int_0^{1+\epsilon} W(1+\epsilon-s)\left[AF\left(s, (x_r)_n\left(h_1(s)\right)\right) - \int_0^s \gamma(s-\tau)F\left(\tau, (x_r)_n\left(h_1(\tau)\right)\right) d\tau\right. \\ \left. + G\left(s, (x_r)_n\left(h_2(s)\right)\right) + Bu_n(s)\right] ds = \sum_{i=1}^{3} I_i.\end{aligned}$$

Since it follows from (H_3) and (H_6) that $F\left(1+\epsilon, (x_r)_n\left(h_1(1+\epsilon)\right)\right)$ and $g\left((x_r)_n(1+\epsilon)\right)$ are bounded in $X_{1+\epsilon}$ uniformly in $n \in \mathbb{N}$, it is clear that I_1, I_2 are both relatively compact in $X_{1+\epsilon}$ as $\left(W(1+\epsilon)\right)_{\epsilon \geq 0}$ and $A^{-(1+\epsilon)}$ are compact operators. Now, we verify I_3 is relatively compact in $X_{1+\epsilon}$ too. For this, taking $-1 < \epsilon < 0$ as above, we calculate similarly that:

$$\begin{aligned}(A^{1+\epsilon} I_3) \leq \left\| \int_0^{1+\epsilon} A^{1+\epsilon} W(1+\epsilon-s) A^{1+2\epsilon} F\left(s, (x_r)_n\left(h_1(s)\right)\right) ds \right\| \\ + \left\| \int_0^{1+\epsilon} A^{1+\epsilon} W(1+\epsilon-s) \int_0^s \gamma(s-\tau)\left[F\left(\tau, (x_r)_n\left(h_1(\tau)\right)\right)\right] d\tau ds \right\| \\ + \left\| \int_0^{1+\epsilon} A^{1+\epsilon} W(1+\epsilon-s)\left(G\left(s, (x_r)_n\left(h_2(s)\right)\right) + Bu_n(s)\right) ds \right\| \\ \leq \frac{(1+2\epsilon)^{\epsilon} C_{1+\epsilon}}{\epsilon}(1+\epsilon)(\|(x_r)\|_{1+\epsilon} + 1) - \frac{(1+2\epsilon)^{-\epsilon} C_{1+\epsilon}}{\epsilon} M_1(1+\epsilon)(\|(x_r)\|_{1+\epsilon} + 1) \\ - \frac{(1+2\epsilon)^{-\epsilon} C_{1+\epsilon}}{\epsilon}(\|g_k(\cdot)\|_{\infty} + M\|u_n\|).\end{aligned}$$

This shows that $\{A^{1+\epsilon}I_3, (x_r)_n \in D(1+\epsilon)\}$ is uniformly bounded in X and I_3 is relatively compact in $X_{1+\epsilon}$. Thus, $D(1+\epsilon)$ is relatively compact in $X_{1+\epsilon}$.

The second assertion can be proved by the similar arguments as verifying the equicontinuity of $\{(Q_{n2}(x_r))(1+\epsilon), x_r \in B_k\}$ in the proofs of Lemma 3.1.

Now, we prove Theorem 3.1 (see [1]).

Proof of Theorem 3.1. We prove that the solution set D is relatively compact in $C([0,1+2\epsilon], X_{1+\epsilon})$. Due to Lemma 3.2, it remains to verify that $D(0)$ is relatively compact in $X_{1+\epsilon}$ and D is equicontinuous at $\epsilon = -1$.

For $(x_r)_n \in D, n \geq 1$, let

$$\overline{(x_r)_n}(1+\epsilon) = \begin{cases} (x_r)_n(1+2\epsilon), & \epsilon \geq -1, \\ (x_r)_n(1+2\epsilon), & \epsilon \geq 0, \end{cases}$$

where δ comes from the condition (H_6). Then, by $(H_6), g((x_r)_n) = g((x_r)_n)$.

By virtue of Lemma 3.2, D is relatively compact in $C\big((0,1+2\epsilon], X_{1+\epsilon}\big)$. Hence, there exists a subsequence of $\{(x_r)_n\}$, denoted by itself, that converges to some function $x_r(\cdot)$ in $C\big((0,1+2\epsilon], X_{1+\epsilon}\big)$, as $n \to \infty$. Thus, by the continuity of g, the strong continuity of $W(1+\epsilon)$ at $\epsilon = -1$ and the fact $g((x_r)_n) = g\big(\overline{(x_r)_n}\big)$, we find:

$$\begin{aligned} &\|(x_r)_n(0) - ((x_r)_0 - g(x_r))\|_{1+\epsilon} \\ &\qquad \leq \left\|W\left(\frac{1}{n}\right) g((x_r)_n) - W\left(\frac{1}{n}\right) g(x_r)\right\| (x_r)_{1+\epsilon} + \left\|W\left(\frac{1}{n}\right) g(x_r) - g(x_r)\right\|_{1+\epsilon} \\ &\qquad = \left\|W\left(\frac{1}{n}\right)[g((x_r)_n) - g(x_r)]\right\|_{1+\epsilon} + \left\|\left[W\left(\frac{1}{n}\right) - I\right] g(x_r)\right\|_{1+\epsilon} \to 0 \; as \; n \to \infty, \end{aligned}$$

i.e., $D(0)$ is relatively compact in $X_{1+\epsilon}$.

On the other hand, for $\epsilon \geq -1$,

$$\|(x_r)_n(1+\epsilon)-(x_r)_n(0)\|_{1+\epsilon}$$
$$= \|W(1+\epsilon)\left[(x_r)_0 + F\left(0,(x_r)_n(h_1(0))\right) - W\left(\frac{1}{n}\right)g((x_r)_n)\right]$$
$$- F\left(1+\epsilon,(x_r)_n(h_1(1+\epsilon))\right)$$
$$+\int_0^{1+\epsilon} W(1+\epsilon-s)\left[AF\left(s,(x_r)_n(h_1(s))\right) - \int_0^s \gamma(s-\tau)F\left(\tau,(x_r)_n(h_1(\tau))\right)d\tau\right.$$
$$\left.+ G\left(s,(x_r)_n(h_2(s))\right) + Bu_n(s)\right]ds$$
$$- \left[(x_r)_0 + F\left(0,(x_r)_n(h_1(0))\right) - W\left(\frac{1}{n}\right)g((x_r)_n) - F\left(0,(x_r)_n(h_1(0))\right)\right\|_{1+\epsilon}$$

$$\leq \left\|\int_0^{1+\epsilon} W(1+\epsilon-s)\left[AF\left(s,(x_r)_n(h_1(s))\right) - \int_0^s \gamma(s-\tau)F\left(\tau,(x_r)_n(h_1(\tau))\right)d\tau\right.\right.$$
$$\left.\left.+ G\left(s,(x_r)_n(h_2(s))\right) + Bu_n(s)\right]ds\right\|_{1+\epsilon} + \|W(1+\epsilon)(x_r)_0-(x_r)_0\|_{1+\epsilon}$$
$$+ \left\|(W(1+\epsilon)-I)W\left(\frac{1}{n}\right)g((x_r)_n)\right\|_{1+\epsilon} + \left\|(W(1+\epsilon)-I)F\left(0,(x_r)_n(h_1(0))\right)\right\|_{1+\epsilon}$$
$$+ \left\|F\left(1+\epsilon,(x_r)_n(h_1(1+\epsilon))\right) - F\left(0,(x_r)_n(h_1(0))\right)\right\|_{1+\epsilon} \to 0,$$

uniformly in n as $\epsilon \to -1$, since $D(0) = \left\{(x_r)_0 - W\left(\frac{1}{n}\right)g((x_r)_n): (x_r)_n \in D\right\}_{n=1}^{\infty}$ is relatively compact and $A^{-(1+\epsilon)}$ is compact. Thus, we infer that the set $D \subseteq C([0,1+2\epsilon],X_{1+\epsilon})$ is equicontinuous at

$\epsilon = -1$, and so D is relatively compact in $C([0,1+2\epsilon],X_{1+\epsilon})$.

Therefore, for $\{(x_r)_n(\cdot)\} \subset D$, we may find an $x_r^*(\cdot)$ in $C([0,1+2\epsilon],X_{1+\epsilon})$ such that (by pass of subsequence if necessary) $(x_r)_n \to x_r^*$ in $C([0,1+2\epsilon],X_{1+\epsilon})$ as $n \to \infty$. Observe that $(x_r)_n, n \in \mathbb{N}^+$, verify the expression of mild solutions for the equation (12), i. e.:

$$(x_r)_n(1+\epsilon) = W(1+\epsilon)\left[(x_r)_0 + F\left(0,(x_r)_n(h_1(0))\right) - W\left(\frac{1}{n}\right)g((x_r)_n)\right]$$
$$- F\left(1+\epsilon,(x_r)_n(h_1(1+\epsilon))\right) + \int_0^{1+\epsilon} W(1+\epsilon-s)[AF\left(s,(x_r)_n(h_1(s))\right)$$
$$- \int_0^s \gamma(s-\tau)F\left(\tau,(x_r)_n(h_1(\tau))\right)d\tau + G\left(s,(x_r)_n(h_2(s))\right) + Bu_n(s)ds,$$

for $\epsilon \geq -1$, taking limit as $n \to \infty$ on both sides, we then obtain that

$$x_r^*(1+\epsilon) = W(1+\epsilon)\left[(x_r)_0 + F\left(0, x_r^*(h_1(0))\right) - g(x_r^*)\right] - F\left(1+\epsilon, x_r^*(h_1(1+\epsilon))\right)$$
$$+ \int_0^{1+\epsilon} W(1+\epsilon-s)\left[AF\left(s, x_r^*(h_1(s))\right) - \int_0^s \gamma(s-\tau)F\left(\tau, x_r^*(h_1(\tau))\right)d\tau\right.$$
$$\left. + G\left(s, x_r^*(h_2(s))\right) + Bu(s)\right]ds,$$

for $\epsilon \geq -1$, which manifests that Eq. 1 has a mild solution $x_r^*(\cdot)$. The existence result is proved.

Now, we prove the approximate controllability of equation (1). That is (see [1]):

Theorem 3.2 Assume that the assumptions (H_0)–(H_6) are satisfied. Additionally, we suppose that the function $F:[0,1+2\epsilon]\times X_{1+2\epsilon} \to X_{2+3\epsilon}$ uniformly bounded in $X_{2+3\epsilon}$, and $G:[0,1+2\epsilon]\times X_{1+2\epsilon} \to X$ and $g:C([0,1+2\epsilon],X_{1+2\epsilon}) \to X_{1+2\epsilon}$ are both uniformly bounded in X. Then, the equation (1) is approximately controllable on $[0,1+2\epsilon]$.

Proof. Let $\bar{x}_r^{1+2\epsilon} \in X, \lambda \in (0,1)$ and $\bar{x}_r^{\lambda}(\cdot):[0,1+2\epsilon] \to X_{1+2\epsilon}$ is the mild solution of equation (1) obtained in Theorem 3.1 under the control $u(1+\epsilon)$ given by Eq. 10. It means that $\bar{x}_r^{\lambda}(\cdot)$ satisfies:

$$\bar{x}_r^{\lambda}(1+2\epsilon) = W(1+2\epsilon)\left[(x_r)_0 + F\left(0, \bar{x}_r^{\lambda}(h_1(0))\right) - g(\bar{x}_r^{\lambda})\right] - F\left(1+2\epsilon\,, \bar{x}_r^{\lambda}(h_1(1+2\epsilon))\right)$$
$$+ \int_0^{1+2\epsilon} W(1+2\epsilon-s)\left[AF\left(s, \bar{x}_r^{\lambda}(h_1(s))\right) - \int_0^s \gamma(s-v)F\left(v, \bar{x}_r^{\lambda}(h_1(v))\right)dv\right.$$
$$\left. + G\left(s, \bar{x}_r^{\lambda}(h_2(s))\right) + Bu(s)\right]ds$$

$$= W(1+2\epsilon)\left[(x_r)_0 + F\left(0, \bar{x}_r^{\lambda}(h_1(0))\right) - g(\bar{x}_r^{\lambda})\right] - F\left(1+2\epsilon\,, \bar{x}_r^{\lambda}(h_1(1+2\epsilon))\right)$$
$$+ \int_0^{1+2\epsilon} AW(1+2\epsilon-s)F\left(s, \bar{x}_r^{\lambda}(h_1(s))\right)ds$$
$$- \int_0^{1+2\epsilon} W(1+2\epsilon-s)\int_0^s \gamma(s-v)F\left(v, \bar{x}_r^{\lambda}(h_1(v))\right)dvds$$

$$+\int_0^{1+2\epsilon} W(1+2\epsilon-s)\Big\{G\left(s,\bar{x}_r^{\lambda}(h_2(s))\right)$$
$$+BB^*W^*(1+2\epsilon-s)R(\lambda,\Gamma_{1+2\epsilon})\Big[\bar{x}_r^{\lambda}$$
$$-W(1+2\epsilon)\left[(x_r)_0+F\left(0,\bar{x}_r^{\lambda}(h_1(0))\right)-g(\bar{x}_r^{\lambda})\right]+F\left(1+2\epsilon\,,\bar{x}_r^{\lambda}(h_1(1+2\epsilon))\right)$$
$$-\int_0^{1+2\epsilon} AW(1+2\epsilon-v)F\left(v,\bar{x}_r^{\lambda}(h_1(v))\right)dv$$
$$+\int_0^{1+2\epsilon} W(1+2\epsilon-v)\int_0^{v}\gamma(v-\tau)F\left(v,\bar{x}_r^{\lambda}(h_1(v))\right)d\tau dv$$
$$-\int_0^{1+2\epsilon} W(1+2\epsilon-v)G\left(v,\bar{x}_r^{\lambda}(h_2(v))\right)dv\Big]\Big\}ds.$$

From the definition of $\Gamma_{1+2\epsilon}$, it follows that:

$$\bar{x}_r^{\lambda}(1+2\epsilon)=\bar{x}_r^{1+2\epsilon}$$
$$+(\Gamma_{1+2\epsilon}R(\lambda,\Gamma_{1+2\epsilon})-I)\Big[\bar{x}_r^{1+2\epsilon}-W(1+2\epsilon)\left[(x_r)_0+F\left(0,\bar{x}_r^{\lambda}(h_1(0))\right)-g(\bar{x}_r^{\lambda})\right]$$
$$+F\left(1+2\epsilon\,,\bar{x}_r^{\lambda}(h_1(1+2\epsilon))\right)-\int_0^{1+2\epsilon} AW(1+2\epsilon-s)F\left(s,\bar{x}_r^{\lambda}(h_1(s))\right)ds$$
$$+\int_0^{1+2\epsilon} W(1+2\epsilon-s)\int_0^{s}\gamma(s-v)F\left(v,\bar{x}_r^{\lambda}(h_1(v))\right)dvds$$
$$-\int_0^{1+2\epsilon} W(1+2\epsilon-s)G\left(s,\bar{x}_r^{\lambda}(h_2(s))\right)ds\Big].$$

$$=\bar{x}_r^{1+2\epsilon}+\lambda R(\lambda,\Gamma_{1+2\epsilon})\Big[\bar{x}_r^{1+2\epsilon}-W(1+2\epsilon)\left[(x_r)_0+F\left(0,\bar{x}_r^{\lambda}(h_1(0))\right)-g(\bar{x}_r^{\lambda})\right]$$
$$+F\left(1+2\epsilon,\bar{x}_r^{\lambda}(h_1(1+2\epsilon))\right)-\int_0^{1+2\epsilon} AW(1+2\epsilon-s)F\left(s,\bar{x}_r^{\lambda}(h_1(s))\right)ds$$
$$+\int_0^{1+2\epsilon} W(1+2\epsilon-s)\int_0^{s}\gamma(s-v)F\left(v,\bar{x}_r^{\lambda}(h_1(v))\right)dvds$$
$$-\int_0^{1+2\epsilon} W(1+2\epsilon-s)G\left(s,\bar{x}_r^{\lambda}(h_2(s))\right)ds\Big].$$

So, we have

$$\left\|\bar{x}_r^{\lambda}(1+2\epsilon)-\bar{x}_r^{1+2\epsilon}\right\|$$

$$=\left\|\lambda R(\lambda,\Gamma_{1+2\epsilon})\left[\bar{x}_r^{1+2\epsilon}-W(1+2\epsilon)\left[(x_r)_0+F\left(0,\bar{x}_r^{\lambda}\left(h_1(0)\right)\right)-g\left(\bar{x}_r^{\lambda}\right)\right]\right.\right.$$

$$+F\left(1+2\epsilon,\bar{x}_r^{\lambda}\left(h_1(1+2\epsilon)\right)\right)-\int_0^{1+2\epsilon} AW\,(1+2\epsilon-s)F\,\left(s,\bar{x}_r^{\lambda}\left(h_1(s)\right)\right)ds$$

$$+\int_0^{1+2\epsilon} W(1+2\epsilon-s)\int_0^{s}\gamma(s-v)F\left(v,\bar{x}_r^{\lambda}\left(h_1(v)\right)\right)dvds$$

$$-\int_0^{1+2\epsilon} W(1+2\epsilon$$

$$\left.\left.-s)G\left(s,\bar{x}_r^{\lambda}\left(h_2(s)\right)\right)ds\right]\right\|. \qquad (14)$$

Due to the compactness of $W(1+\epsilon),\epsilon\geq 0$, and the uniform boundedness of g,F, we see that there are subsequences of $W(1+2\epsilon)\left[F\left(0,\bar{x}_r^{\lambda}\left(h_1(0)\right)\right)-g\left(\bar{x}_r^{\lambda}\right)\right]$, still denoted by itself, converging to some $\tilde{x}_r^1\in X$, as $\lambda\to 0^+$.

Since $F\left(1+2\epsilon,\bar{x}_r^{\lambda}\left(h_1(1+2\epsilon)\right)\right)$ is bounded in $X_{2+3\epsilon}$, it is also compact in X from the compactness of $A^{-(2+3\epsilon)}$, and hence there is $(\tilde{x}_r)_2\in X$ such that (by passing to a subsequence if necessary)

$F\left(1+2\epsilon,\bar{x}_r^{\lambda}\left(h_1(1+2\epsilon)\right)\right)\to(\tilde{x}_r)_2\in X$ in $\|\cdot\|$ as $\lambda\to 0^+$.

On the other hand, using the uniform boundedness of $F:[0,1+2\epsilon]\times X_{1+2\epsilon}\to X_{2+3\epsilon}$ and $G:[0,1+2\epsilon]\times X_{1+2\epsilon}\to X$ again, we find that $\left\{F\left(s,\bar{x}_r^{\lambda}\left(h_1(s)\right)\right)\right\}$ and $\left\{G\left(s,\bar{x}_r^{\lambda}\left(h_2(s)\right)\right)\right\}$ are both uniform bounded in $L^2([0,1+2\epsilon],X)$. Thus, there exist subsequences still denoted by $\left\{F\left(s,\bar{x}_r^{\lambda}\left(h_1(s)\right)\right)\right\}$ and $\left\{G\left(s,\bar{x}_r^{\lambda}\left(h_2(s)\right)\right)\right\}$ that converge weakly to say $\tilde{F}(s)$ and $\tilde{G}(s)$ in $L^2([0,1+2\epsilon],X)$, respectively. Furthermore, similarly to the proof of the compactness of Q_{n2} in Lemma 3.1, one can easily verify that the maps $x_r(1+\epsilon)\to\int_0^{1+\epsilon} AW(1+\epsilon-s)x_r(s)ds{:}L^2([0,1+2\epsilon],X_{2+3\epsilon})\to C([0,1+2\epsilon],X)$ and $x_r(1+\epsilon)\to\int_0^{1+\epsilon} W(1+\epsilon-s)x_r(s)ds{:}L^2([0,1+2\epsilon],X)\to C([0,1+2\epsilon],X)$ are compact. As a result, we infer immediately that:

$$\int_0^{1+2\epsilon} AW(1+2\epsilon-s)\left(F\left(s,\bar{x}_r^{\lambda}\left(h_1(s)\right)\right)-\tilde{F}(s)\right)ds\to 0,\qquad as\quad \lambda\to 0^+,$$

and

$$\int_0^{1+2\epsilon} W(1+2\epsilon-s)\left(G\left(s,\bar{x}_r^{\lambda}(h_2(s))\right)-\tilde{G}(s)\right)ds\to 0, \qquad as \quad \lambda\to 0^+.$$

Combining (14) with above assertions, we find that:

$$\begin{aligned}
&\left\|\bar{x}_r^{\lambda}(1+2\epsilon)-\bar{x}_r^{1+2\epsilon}\right\| \\
&\quad\le \left\|\lambda R(\lambda,\Gamma_{1+2\epsilon})(\bar{x}_r^{1+2\epsilon}-W(1+2\epsilon)(x_r)_0-(\tilde{x}_r)_1+(\tilde{x}_r)_2)\right\| \\
&\quad+\left\|\lambda R(\lambda,\Gamma_{1+2\epsilon})\left(W(1+2\epsilon)\left(F\left(0,\bar{x}_r^{\lambda}(h_1(0))\right)-g(\bar{x}_r^{\lambda})\right)-(\tilde{x}_r)_1\right)\right\| \\
&\quad+\left\|\lambda R(\lambda,\Gamma_{1+2\epsilon})\left(F\left(1+2\epsilon,\bar{x}_r^{\lambda}(h_1(1+2\epsilon))\right)-(\tilde{x}_r)_2\right)\right\| \\
&\quad+\left\|\lambda R(\lambda,\Gamma_{1+2\epsilon})\int_0^{1+2\epsilon} AW(1+2\epsilon-s)\left(F\left(s,\bar{x}_r^{\lambda}(h_1(s))\right)-\tilde{F}(s)\right)ds\right\| \\
&+\left\|\lambda R(\lambda,\Gamma_{1+2\epsilon})\int_0^{1+2\epsilon} AW(1+2\epsilon-s)\tilde{F}(s)ds\right\| \\
&\quad+\left\|\lambda R(\lambda,\Gamma_{1+2\epsilon})\int_0^{1+2\epsilon} W(1+2\epsilon-s)\int_0^{s}\gamma(s-v)\left(F\left(v,\bar{x}_r^{\lambda}(h_1(v))\right)\right.\right. \\
&\quad\left.\left.-\tilde{F}(v)\right)dvds\right\|+\left\|\lambda R(\lambda,\Gamma_{1+2\epsilon})\int_0^{1+2\epsilon} W(1+2\epsilon-s)\int_0^{s}\gamma(s-v)\tilde{F}(v)dvds\right\| \\
&+\left\|\lambda R(\lambda,\Gamma_{1+2\epsilon})\int_0^{1+2\epsilon} W(1+2\epsilon-s)\left(G\left(s,\bar{x}_r^{\lambda}(h_2(s))\right)-\tilde{G}(s)\right)ds\right\| \\
&\quad+\left\|\lambda R(\lambda,\Gamma_{1+2\epsilon})\int_0^{1+2\epsilon} W(1+2\epsilon-s)\tilde{G}(s)ds\right\|\to 0, \qquad as \quad \lambda\to 0^+.
\end{aligned}$$

So $\bar{x}_r^{\lambda}(1+2\epsilon)\to\bar{x}_r^{1+2\epsilon}$ holds in X, which manifests the approximate controllability of system (1). The proof is complete.

4 An Example

As an application of the Theorem 3.2, we consider the approximate controllability for the following neutral integro-differential equation with nonlocal condition (see [1]):

$$\begin{cases} \dfrac{\partial}{\partial(1+\epsilon)}\left[z(1+\epsilon,x_r)+\displaystyle\int_0^{\pi} a(y_r,x_r)\sin\left(z(1+\epsilon,y_r)+\frac{\partial}{\partial y_r}z(1+\epsilon,y_r)\right)dy_r\right]=\frac{\partial^2}{\partial x_r^2}z(1+ \\ +\displaystyle\int_0^{1+\epsilon} b(1+\epsilon-s)\frac{\partial^2}{\partial x_r^2}z(s,x_r)ds+c\left(1+\epsilon,z(\sin 1+\epsilon\,,x_r),\frac{\partial}{\partial x_r}z(\sin 1+\epsilon\,,x_r)\right)+u(1+\epsilon,x_r),0\le \\ z(1+\epsilon,0)=z(1+\epsilon,\pi)=0, \qquad \epsilon\ge -1, \\ z(0,x_r)+\displaystyle\sum_{i=1}^{p}\cos\big(z(1+i\epsilon,x_r)\big)=z_0(x_r), \qquad 0\le x_r\le\pi, \end{cases}$$

where $1+2\epsilon\le\pi,\epsilon>0,p\in\mathbb{N}^+,z_0(x_r)\in X:=L^2([0,\pi]).b(\cdot)$ is continuous, then there exists a constant $M_1>0$ such that $\|b(\cdot)\|\le M_1$.

We assume that the functions $a(\cdot,\cdot),k(\cdot,\cdot)$, and $c(\cdot,\cdot,\cdot)$ satisfy, respectively, the following conditions.

(a_1) The function $a\colon[0,\pi]\times[0,\pi]\to\mathbb{R}$ verifies that:

(i) The function $\frac{\partial^2}{\partial x_r^2}a(y_r,x_r)$ is measurable and

$$N_1=\left[\int_0^{\pi}\int_0^{\pi}\left(\frac{\partial^2}{\partial x_r^2}a(y_r,x_r)\right)^2dy_rdx_r\right]^{\frac{1}{2}}<\infty;$$

(ii) $a(y_r,0)=a(y_r,\pi)=0$ for each $y_r\in[0,\pi]$.

$(a_2)b(\cdot)\in L^1(\mathbb{R}^+)\cap C^1(\mathbb{R}^+)$ with primitive $B(1+\epsilon)\in L^1_{loc}(\mathbb{R}^+)$. Here, $B(1+\epsilon)$ is nonpositive, nondecreasing, and $B(0)=-1$. Moveover, the scalar function $b(\cdot)$ satisfies that $\lambda\in\Lambda$ implies

$\psi(\lambda):=1+b^*(\lambda)\neq 0$, and $\lambda\psi(\lambda)\in\Lambda$, further, $b^*(\lambda)\to 0$ as $|\lambda|\to\infty,\lambda\in\Lambda$.

(a_3) The function $c\colon[0,1+2\epsilon]\times\mathbb{R}\times\mathbb{R}\to\mathbb{R}$ is continuous, and there is a constant $C>0$ such that $|c(1+\epsilon,x_r,y_r)|\le C$, for any $(1+\epsilon,x_r,y_r)\in[0,1+2\epsilon]\times\mathbb{R}\times\mathbb{R}$.

Now, we need to rewrite equation (15) in the form of Eq. 1 and verify all the conditions of Theorem 3.2. To this, let $\big(A,D(A)\big)$ be defined by:

$$Az=-z''$$

with the domain:

$$D(A)=\{z(\cdot)\in X\colon z',z''\in X, \qquad \text{and } z(0)=z(\pi)=0\}.$$

It is well known that $-A$ generates a strongly continuous semigroup $\big(S(1+\epsilon)\big)_{\epsilon\ge -1}$ which is compact, analytic, and self-adjoint. Furthermore, A has a discrete spectrum, the eigenvalues are $n^2,n\in\mathbb{N}$, with

the corresponding normalized eigenvectors $\xi_n(x_r) = \sqrt{\frac{2}{\pi}}\sin(nx_r)\,, n = 1, 2, \ldots$. Then, the following properties hold:

(i) If $z \in D(A)$, then

$$Az = \sum_{n=1}^{\infty} \quad n^2\langle z, \xi_n\rangle\xi_n.$$

(ii) For each $z \in X$,

$$A^{-\frac{1}{2}}z = \sum_{n=1}^{\infty} \quad \frac{1}{n}\langle z, \xi_n\rangle\xi_n.$$

In particular, $\left\|A^{-\frac{1}{2}}\right\| = 1$.

(iii) The operator $A^{\frac{1}{2}}$ is given by

$$A^{\frac{1}{2}}z = \sum_{n=1}^{\infty} \quad n\langle z, \xi_n\rangle\xi_n$$

on the space

$$D\left(A^{\frac{1}{2}}\right) = \left\{z(\cdot) \in X, \sum_{n=1}^{\infty} \quad n\langle z, \xi_n\rangle\xi_n \in X\right\}.$$

We know that, for the operator $\left(-A, D(A)\right)$, there is $\varphi \in (0, \pi/2)$ such that:

$$\Lambda := \left\{\lambda \in C: |\arg\lambda| < \frac{\pi}{2} + \varphi\right\} \subset \rho(-A),$$

where $\rho(-A)$ denotes the resolvent set of $-A$. Then, from (a_2) the conditions (V_1')–(V_3') are verified, and hence the linear equation for equation (15) has a family of resolvent operators $\left(W(1+\epsilon)\right)_{\epsilon\geq -1}$, which is given by, for $x_r \in X$:

$$W(1+\epsilon)x_r = \frac{1}{2\pi i}\int_{\Gamma} \quad e^{\lambda(1+\epsilon)}\rho(\lambda)x_r d\lambda = \frac{1}{2\pi i}\int_{\Gamma} \quad e^{\lambda(1+\epsilon)}\psi^{-1}(\lambda)(\lambda\psi^{-1}(\lambda) + A)^{-1}x_r d\lambda,$$

where Γis described in Section 2. It is readily seen that $W(1+\epsilon)$ is compact for all $\epsilon \geq 0$, since $R(\lambda, -A)$ is compact for any $\lambda \in \rho(A)$. So, the assumption (H_1) holds for all $\epsilon \geq 0$.

Here, we choose $\epsilon = 0, \gamma(1+\epsilon) = b(1+\epsilon)A$, and define respectively the functions $F: [0, 1+2\epsilon] \times X_{1\,2} \to D(A), G: [0, 1+2\epsilon] \times X_{\frac{1}{2}} \to X$ and $g: C\left([0, 1+2\epsilon], X_{\frac{1}{2}}\right) \to X_{\frac{1}{2}}$ as:

$$F(1+\epsilon,z)(x_r) = F(z)(x_r) = \int_0^{\pi} a(y_r,x_r)\sin\big(z(y_r)+z'(y_r)\big)\,dy_r,$$

$$G(1+\epsilon,z)(x_r) = c\big(1+\epsilon,z(x_r),z'(x_r)\big)$$

and

$$g\big(z(1+\epsilon,x_r)\big) = g(z)(x_r) = \sum_{i=1}^{p} \cos\big(z(1+i\epsilon,x_r)\big).$$

Additionally, we put $\gamma(\cdot) = b(\cdot)A$ and $B = I$. Then, equation (15) can be well rewritten as the abstract form (1).

Let us examine now that for this system the conditions in Theorem 3.2 are all fulfilled. First, it is clear that the operator B satisfies (H_2) and the family $\gamma(\cdot)$ satisfies condition (H_4). Moreover, from the relation (cf. [42]),

$$\|z_2 - z_1\| \le \|z_2 - z_1\|_{\frac{1}{2}},$$

one can easily see that $F: X_{\frac{1}{2}} \to X_1$ is Lipschitz continuous and satisfies the assumption (H_3). Furthermore, for any $(\cdot) \in X_{\frac{1}{2}}$,

$$\|F(z)\|_1^2 = \|AF(z)\|^2 = \sum_{n=1}^{\infty} \left|\left\langle \int_0^{\pi} \frac{\partial^2 a(y_r,x_r)}{\partial x_r^2}\sin\big(z(y_r)+z'(y_r)\big)\,dy_r, \xi_n\right\rangle\right|^2$$

$$\le \pi \int_0^{\pi}\int_0^{\pi} \left(\frac{\partial^2 a(y_r,x_r)}{\partial x_r^2}\right)^2 dy_r dx_r,$$

it then follows from (a_1) that F is uniformly bounded. The assumption (a_3) guarantees that G satisfies (H_5) and is uniformly bounded. The function g is also uniformly bounded and verifies the condition (H_6). Finally, according to ([24] Lemma 4.1), the linear system corresponding to Eq. 15 is approximately controllable on [0, T]; hence, (H_0) holds too. Thus, all the conditions of Theorem 3.2 are well satisfied. Consequently, from Theorem 3.2, equation (15) is approximately controllable on $[0, 1+2\epsilon]$.

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