

**Stress related nail biting, signs and consequences  
A questionnaire among school kids in Tripoli Libya region: Part I**

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**Abstract:** The purpose of this study was to analyze and determine the extent of the prevalence of nail-biting habit among school kids and to determine its relationship to dental health. The study was conducted from the age of 9-18 years old and it consisted of questionnaire included name, age, gender, school year, class, place of residence of the student, educational level, the delivery of the student to school by his parents or alone, the number of fingers that are being bitten, and the health statue of the mouth. The incidence of nail biting in Tripoli Libya , was most were boys at a rate of 59.5%, and the highest percentage was in the age of 9-12, at a rate of 51.7%, and the highest percentage in the academic level was excellent at 47%. These cases are not hereditary, with a percentage of 85.5%, and the use of both hands by 65.68%, and the biting of the ten fingers by 54.68%. while due to boring by 69.2% case detection there were 45.5% caries cases. Most of them are in milk teeth, with a rate of 54.83%. **Conclusion,** Nail biting can be a chronic and debilitating habit that may continue into adulthood and can be a source of disease, but it can contribute to severe psychosocial distress. In such cases, we need to educate people, stimulate good habits, and develop awareness when thinking that When considering that nail biting can transmit deadly disease, breaking this habit can be lifesaving.

**KEYWORDS:** complication; nail biting, bad habits, kids psychology.

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**INTRODUION**

Nail biting is one of the most common habits among children and adolescents ,as this condition starts from childhood and may continue until and adulthood . the time is for sometimes temporary' parents should

pay attention to what calls the child to bite his nails and try to talk to him ,but if the child does not stop the biting process usually continues throughout the day and may cause infection to his hands with wounds and cracks ' then search for radical solutions for the problem should be found.

Nail biting NB has been a less-published area in the literature of both of psychiatry and dermatology<sup>(1)(2)</sup> medicine ,psychology and dentistry have been unable to resolve the problem of NB<sup>(3)</sup> while individuals whoPracticeNB usually like to stop it, their efforts to put an end to it havefailed.

The parents of a sizable number of children,whom are referred to clinics for the management of NB, have tried to help their children by means such as coating nail plate white substance that have unpleasant taste. Sometime they have covered the nails with rubber or cloth fingers protectors. These measures do not usually lead to a permanent fading of this behavior.

Many of children with NB behavior may be punished by their parents or family members. Punishment and threat may not lead to the decrease of NBfrequency, in fact may lead to an increase in it. Sometimes,individuals whit NB behavior may say that they are powerless or unable to stop this unwanted behavior. there is aspeculation that NB may guide clinicians to a better pharmacological management of children with attention deficit hyperactivity disorder ADHD<sup>(4)</sup>.

#### **AIMS AND OBJECTIVES**

The aim and objectives of this project is to study and determine the extent of the prevalence of nail-biting habit among school students and to determine its relationship to dental health.

#### **MATERIALS AND METHODS**

This study was conducted from the age of 9-18 years and it consisted of questionnaire included name, age, gender, school year, class, place of residence of the student, educational level, marital status, and the delivery of the student to school by his parents or alone. No, the number of fingers that are bitten, and the child's habit of this habit when and the health statue of the mouth.

#### **Statistical Analysis**

This study used the descriptive survey method, where the main instrument used was the questionnaire. In any case, the data to be analyzed was obtained from the students' answers to the questionnaire questions. Moreover, the questionnaire can be divided into four main sections to help us in the research process, these sections were as follows:

- Firstly, personal information including age, gender, school year, educational level, and marital status.
- Secondly, nail biting habit information including family history, type of hands bitten and total number of finger bitten.
- Thirdly, oral health condition information and,
- Finally, information about the state of health of the case in general.

Consequently, the data were obtained in a spreadsheet of Excel program for Windows, checked and then imported into the Statistical Package for Social Sciences (IBM SPSS V.21) to perform the statistical analysis steps.

#### Statistical analysis technique

The statistical analysis technique on which the researcher relied upon in this practical aspect can be summarized in the following points:

- Descriptive statistics have been calculated, such as frequencies, percentages, means, and standard deviation.
- Graphic representation to clarify the percentages of data and means.
- Independent samples t-test was done as the test of a statistically difference between males and females.
- Chi-square test was done as the test of a statistically association between two categorical variables.

**Note that:** Statistical tests were performed to determine the significance of finding. The data statistically significance was defined as  $p < 0.05$ .

#### RESULTS

##### • Personal Information of Study Sample

Table 1. Frequency and relative distribution of the study sample according to gender.

Gender	Frequency (N)	Percent (%)
Boys	206	59.5%
Girls	140	40.5%
Total	346	100%

From Table (1) we can observe that, the total number of students who suffer from nail biting habit (NBh) is (346). However, according to gender the majority of study sample were boys 206 (59.5%) and 140

(40.5%) girls. From the sample data, it is clear that boys with NBh are more than girls with a difference of 19%. Figure (1) illustrates the relative distribution of survey participants regarding gender.

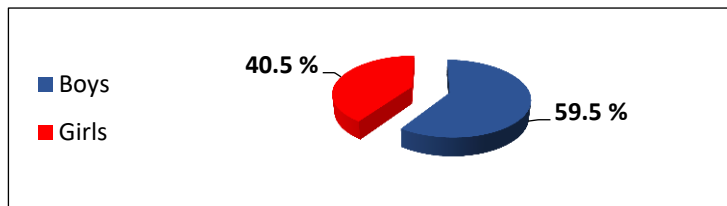


Figure 1. The relative distribution of the study sample regarding gender.

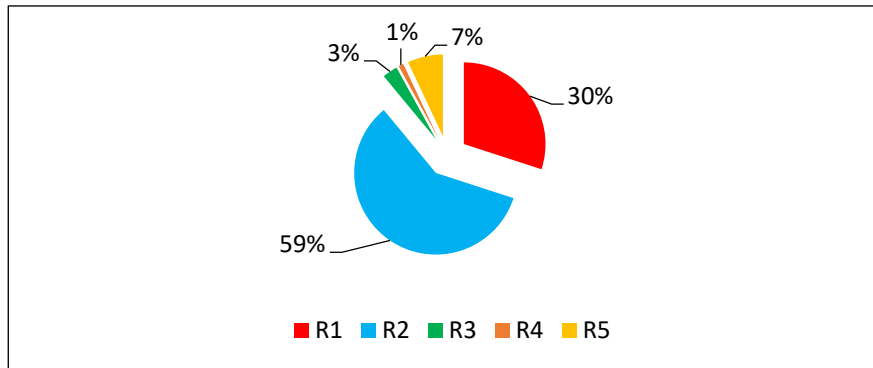
**Table 2.** Frequency and relative distribution of the study sample according to School and gender.

School	Gender				Total (N)	%
	Boys		Girls			
	N	%	N	%		
SC 1	19	5.5%	10	2.9%	29	8.3%
SC 2	10	2.9%	11	3.2%	21	6.1%
SC 3	41	11.8%	0	0.0%	41	11.8%
SC 4	68	19.7%	69	19.9%	137	39.6%
SC 5	34	9.8%	34	9.8%	68	19.7%
SC 6	34	9.8%	16	4.6%	50	14.5%
Total (N)	206	59.5%	140	40.5%	346	100%

Notes: SC 1 =martyr abdalmoneimriyad school; SC 2 =flowers school; SC 3 =martyr bashirsoula school; SC 4 =southern maya school; SC 5 = ibn Khaldun school and SC 6 =the school of the renewed futuer.

Table (2) presents the frequency and relative distribution of the study sample according to school and gender. It is clear from Table 2 that, School 4, which is the Southern Al-Maya School, has the largest number of students who suffer from the habit of NB, where the total number of students was (137, 39.6%), and the number of boys was (68, 19.7%), and the number of girls was (69, 19.9%). In School 2, the number of students was (21, 6.1%), with (10, 2.9%) boys and (11, 3.2%) girls. In addition, Figure 2 shows the relative distribution of the study sample according to School and gender.





**Figure 3.** Relative distribution of the study sample according to the area of residence.

**Table 4.** Frequency and relative distribution of the study sample according to age and gender.

Age (in years)	Gender				Total		P-value
	Boys		Girls		N	%	
	N	%	N	%			
9 – 12	100	29.1%	78	22.7%	178	51.7%	0.000
13 – 16	80	23.3%	62	18.0%	142	41.3%	
17 – 20	24	7.0%	0	0.0%	24	7.0%	
<b>Total (N)</b>	<b>204</b>	<b>59.3%</b>	<b>140</b>	<b>40.7%</b>	<b>344</b>	<b>100%</b>	
Age (Mean ±SD)	13.14 ± 2.511		12.26 ± 1.774		12.81 ± 2.275		

SD = Standard Deviation.

Independent Samples t-test was done as the test of significance.

From Table (4) we can observed that, in study sample boys were (204, 59.3%) with a mean age of 13.14 year (SD=2.511) and (140, 40.7%) girls with a mean age of 12.26 year (SD=1.774). According to the age groups, we note that the number of students who have NBh is most prevalent at the age group of 9-12 years (178, 51.7%), , where the number of boys reached 100, representing a percentage (29.1%), while the number of girls was (78, 22.7%).Then, the number of NBh in the age group 13-16 was (80, 23.3%) boys and (62, 18%) girls. In contrast, the number of students with NBh in age group 17-20 with (24, 7%) boys was few compared to other age. Moreover, there was a statistically significant difference in age between boys and girls ( $P = 0.00$ ;  $P < 0.05$ ). In all age groups, boys outnumbered girls with a statistically significant

difference. Figure (4) illustrates the relative distribution of study sample according to gender and age groups.

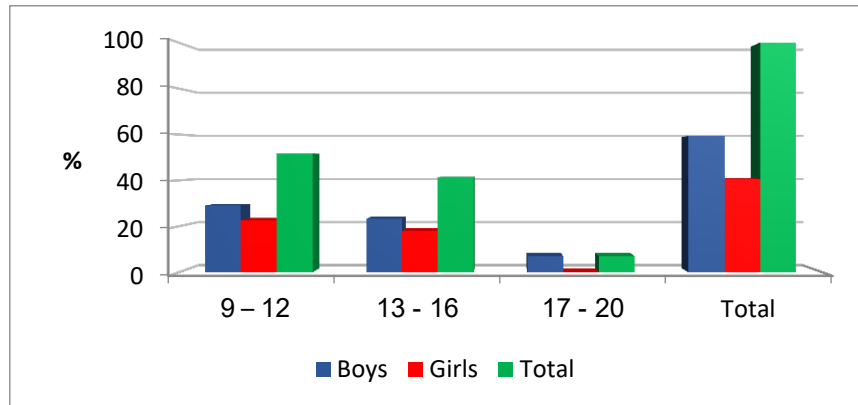


Figure 4. Relative distribution of study sample according to gender and age groups.

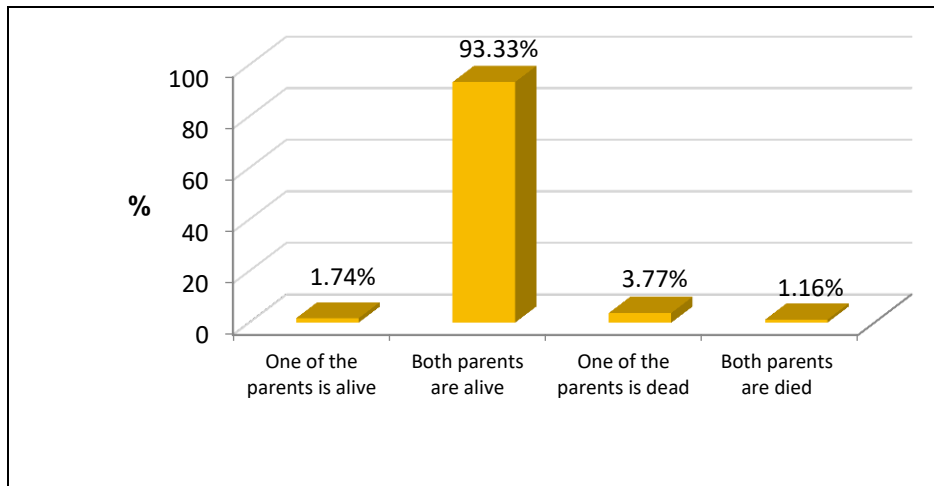
Academic level	Gender				Total		P-value
	Boys		Girls		N	%	
	N	%	N	%			
Weak	4	1.2%	0	0%	4	1.2%	0.000
Acceptable	8	2.3%	5	1.4%	13	3.8%	
Good	22	6.4%	8	2.3%	30	8.7%	
Very good	75	21.7%	24	7%	99	28.7%	
Excellent	83	24.1%	79	22.9%	162	47%	
Very Excellent	14	4.1%	23	6.7%	37	10.7%	
Total (N)	206	0.597	139	0.403	345	100%	

From Table (5), we notice that the academic level of most students, despite their nail biting habit, was excellent (162, 47%), of whom (83, 24.1%) were boys and (79, 22.9%) were girls. In the very good level, they were (99, 28.7%), of whom (75, 21.7%) are boys and (24, 7%) are girls. As for the two levels of weak and acceptable, the number of students and their percentages were few compared to the rest of the levels, which were (4, 1.2%) and (13, 3.8%) respectively. Moreover, the Pearson Chi-Square test was used for association between academic level and gender. Result in Table (5) shows that ( $P = 0.000$ ;  $P < 0.05$ ), so we can conclude that, academic level and gender is dependent and there is significant relationship at 5% significance level. Figure (5) illustrates the





(6,1.74%), while the students whose parents are dead were (13, 3.77%), and the students whose one of their parents is dead were (4, 1.16 %). Figure (6) below shows the relative distribution of the study sample according to their marital status.



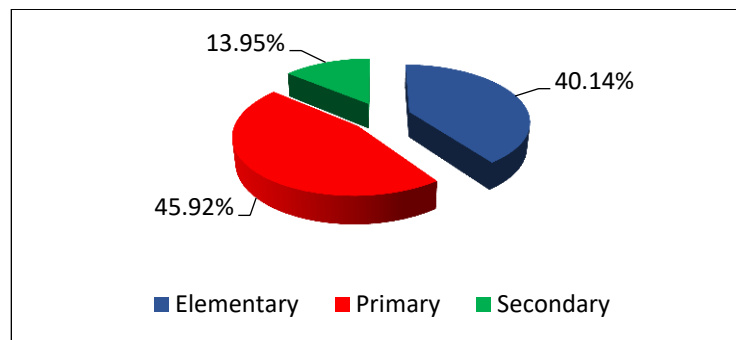
**Figure 6.** Relative distribution of study sample according to marital status.

**Table 7.** Frequency and relative distribution of the study sample according to their academic year.

Academic year	Frequency (N)	Percent (%)
Primary	118	40.14%
Preparatory	135	45.92%
Secondary	41	13.95%

Table (7) shows the frequency and relative distribution of the study sample according to the academic years. It is clear from Table (7) that most of the students with the habit of nail biting are in the preparatory

academic stage (135, 45.92%; then, the primary stage (118, 40.14%), while the number of students with NBh in the secondary stage has decreased (41, 13.95%). Figure (7) shows the frequency and relative distribution of the study sample according to the academic years.



**Figure 7.** Relative distribution of the study sample according to their academic year.

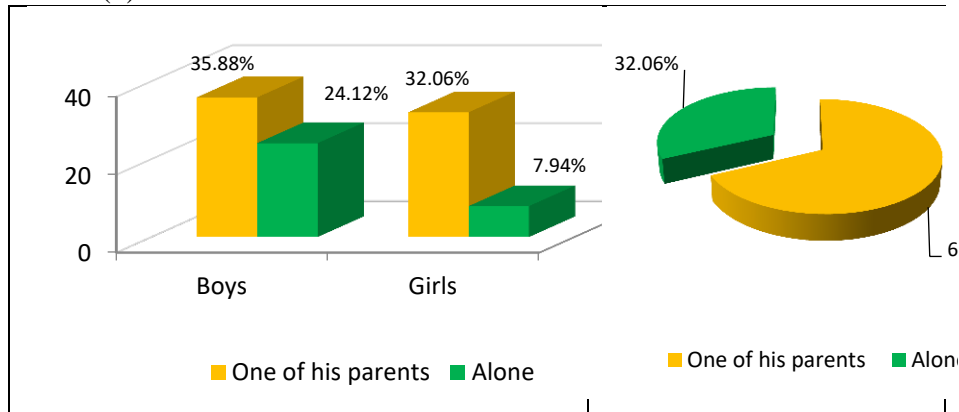
To answer the question related to going student to school, there were two options to answer, which is whether by one of his parents or alone. Table (8) summarizes the answers to this question according to the gender of the student.

**Table 8.** Frequency and relative distribution related to going student to school according to gender.

Going School to	Gender				Total	
	Boys		Girls			
	N	%	N	%	N	%
One of his parents	122	35.88%	109	32.06%	231	67.94%
Alone	82	24.12%	27	7.94%	109	32.06%
<b>Total (N)</b>	204	60%	136	40%	340	100%

Table (8) shows that most of the students (231, 67.94%), whether boys (122, 35.88%) or girls (109, 32.06%) reach their schools with the help of one of their parents, while the rest, which are about (109, 32.06%), of whom (82, 24.12%) are boys and (27, 7.94%) girls, go to their schools

alone. Figure (8) shows the relative frequency distribution for data in Table (8).



**Figure 8.** Frequency and relative distribution related to going student to school according to gender.

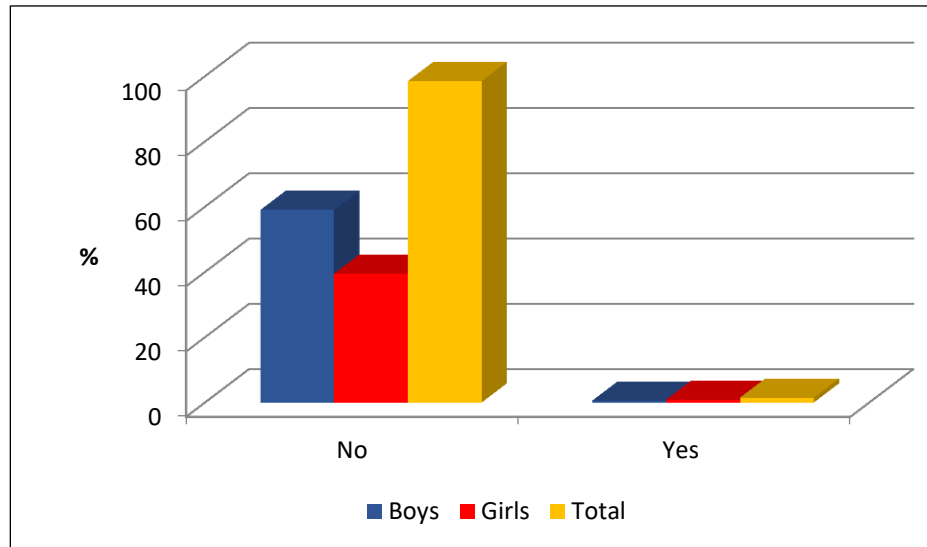
**Nail Biting Habit Information :-**

Q- Does one of the parents have a habit of biting nails?

**Table 9.** Frequency and relative distribution related to family history of NBh according to gender.

Parents have a habit of biting nails	Gender				Total	
	Boys		Girls			
	N	%	N	%	N	%
No	197	59%	132	39.50%	329	98.50%
Yes	2	0.60%	3	0.90%	5	1.5%
<b>Total (N)</b>	199	59.60%	135	40.40%	334	100%

From Table (9) we can say that, in total (334) of students, there were (329; 59%) cases, (197, 59%) boys and (132, 39.5%) girls that did not have family history of NBh. In contrast, (5; 1.5%) of students a family history of NBh, where the number of boys was (2; 0.60%), and the number of girls was (3; 0.90%).Figure (9) illustrates the family history of NBh according to gender.



**Figure 9.** The family history of NBh according to gender.

**Q - The student suffers from the habit of biting the nails of the right hand, the left hand, or both hands.**

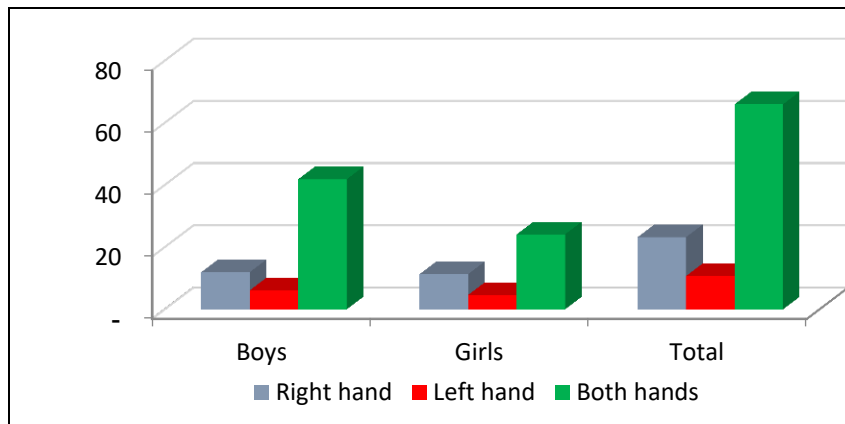
**Table 10.** Distribution of Type of hands bitten according to gender.

Type of hands bitten	Gender				Total	
	Boys		Girls			
	N	%	N	%	N	%
Right hand	41	11.92%	39	11.34%	80	23.26%
Left hand	21	6.10%	16	4.65%	37	10.76%
Both hands	144	41.86%	83	24.13%	227	65.98%
<b>Total (N)</b>	206	59.88%	138	40.12%	344	100%

Pearson Chi-Square = 3.825 and  $P = 0.148$

From Table (10) it can be seen that from the total of 344 students, both hands bitten by the students (227, 65.98%) was more frequent in general with boys number (144, 41.86%) which is more than in girls (83; 24.13%). Right hand bitten (80, 23.26%) was almost frequent in similar

proportions in boys (41; 11.92%) and in girls (39; 11.34 %). Left hands (37, 10.76%) were more frequent in boys (21, 6.10%) than in girls (16; 24.13%). Moreover, the Pearson Chi-Square test was used for association between type of hands bitten by students and gender. Result in Table (10) shows that ( $P = 0.148$ ;  $P > 0.05$ ), so we can conclude that, type of hands bitten by students and gender is independent and there is an insignificant relationship at 5% significance level. Figure (10) displays the relative distribution of the type of hands bitten by student according to gender.



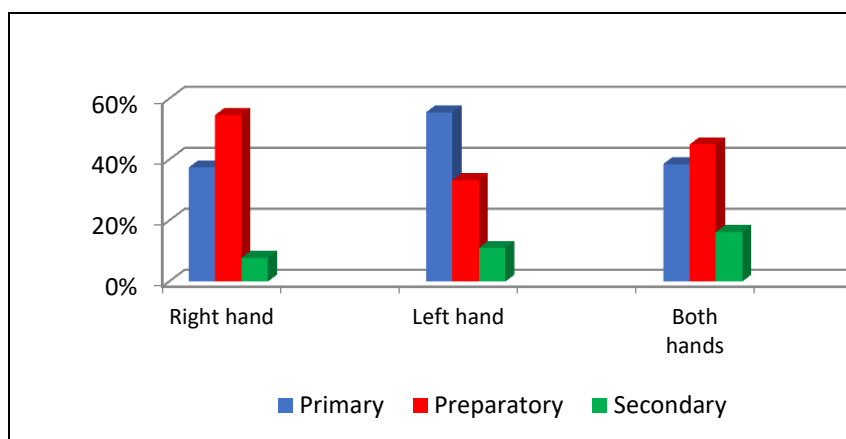
**Figure 10.** Relative distribution of the type of hands bitten by student according to gender.

**Table 11.** Distribution of Type of hands bitten according to academic year.

Academic year		Type of hands bitten			P-value
		Right hand	Left hand	Both hands	
Primary	<i>N</i>	24	15	78	<b>0.161</b>
	%	37.5%	55.6%	38.6%	
Preparatory	<i>N</i>	35	9	91	
	%	54.7%	33.3%	45.0%	
Secondary	<i>N</i>	5	3	33	
	%	7.8%	11.1%	16.3%	
<b>Total (N)</b>		<i>N</i> 64	27	202	
Pearson Chi-Square = 6.561 and $P = 0.161$					

Table (11) shows the frequency and relative distribution of the study sample according to the academic year and type of hands bitten. It is clear that, bitten the nails of both hands is more frequent in study sample compared to biting right or left hands, and we note that it is more visible in the preparatory years (91, 45%), then the primary years (78, 38.6%) the secondary years (33, 16.3%). Biting the nails of the right hand is more common in the preparatory years (35, 54.7%), then the primary years (24, 37.5%) and then the secondary year (5, 7.8%). Biting the nails of the left hand is more common in the primary years (15, 55.6%), then the preparatory years (9, 33.3%) and then the secondary years (3, 11.1%). Moreover, the Pearson Chi-Square test was used for association between type of hands bitten by students and academic year. Result shows that ( $P = 0.161$ ;  $P > 0.05$ ), so we can conclude that, type of hands bitten by students and academic year is independent and there is an insignificant relationship at 5% significance level. Figure (11) displays the relative distribution of type of hands bitten according to academic year.

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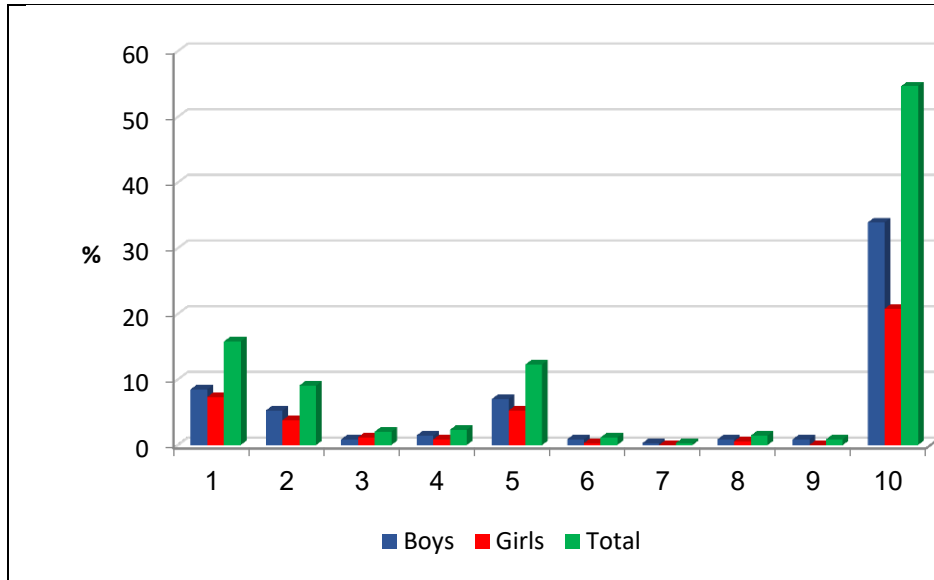


**Figure 11.** Distribution of Type of hands bitten according to academic year.

Type of hands bitten	Gender				Total	
	Boys		Girls			
	N	%	N	%	N	%
1	29	8.48%	25	7.31%	54	15.79%
2	18	5.26%	13	3.80%	31	9.06%
3	3	0.88%	4	1.17%	7	2.05%
4	5	1.46%	3	0.88%	8	2.34%
5	24	7.02%	18	5.26%	42	12.28%
6	3	0.88%	1	0.29%	4	1.17%
7	1	0.29%	0	0.00%	1	0.29%
8	3	0.88%	2	0.58%	5	1.46%
9	3	0.88%	0	0.00%	3	0.88%
10	116	33.92%	71	20.76%	187	54.68%
<b>Total</b>	205	59.94%	137	40.06%	342	100%

Table (12) shows that, the majority of students (187, 54.68%) in the study sample bite their whole fingers, (116, 33.92%) of them are boys and (71, 20.76%) are girls, followed by one fingers (54, 15.79%) and five

fingers (42, 12.28%). Figure (12) displays the relative distribution of Total finger bitten according to gender.



**Figure 12.** Distribution of Total finger bitten according to gender.

- **The student has a habit of biting nails when Boredom, Stress or Frustration:-**

**Table 13.** Frequency and relative distribution of the student has a habit of biting nails when Boredom, Stress or Frustration.

	Gender				Total		P-value
	Boys		Girls		N	%	
	N	%	N	%			
Boring	146	42.8%	90	26.4%	236	69.2%	0.323
Stress	59	17.3%	46	13.5%	105	30.8%	
Frustration	0	0.0%	0	0.0%	0	0.0%	
Total (N)	205	60.1%	136	39.9%	341	100.0%	



Table (13) presents that, most of the students in the study sample biting nail of fingers when they are bored, where their number was (236, 69.2%), including (146, 42.8%) boys and (90, 26.4%) girls, while the students who do this habit when they feel pressure, they were (105, 30.8%) of them (59, 17.3%) boys and (46, 13.5%) girls, in contrast, there are no answers about the habit of biting nails when feeling frustrated. Figure (13) displays the distribution of the student has a habit of biting nails when Boredom, Stress or Frustration.

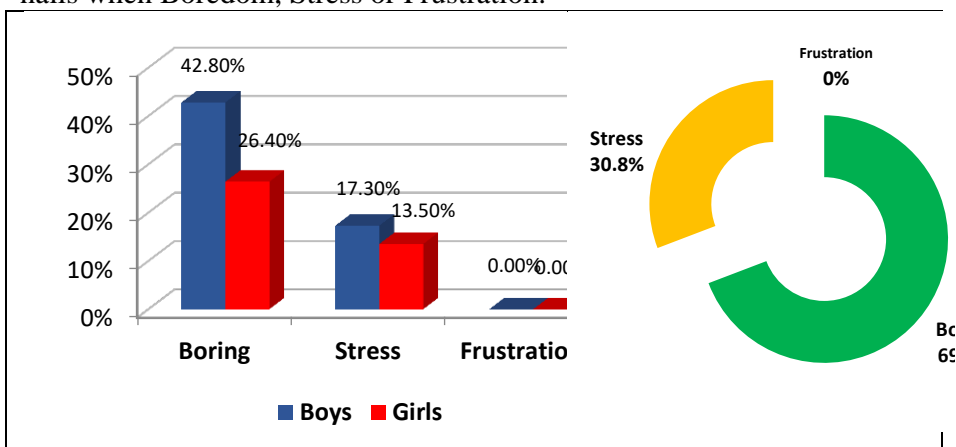


Figure 13. Frequency and relative distribution for the student has a habit of biting nails when Boredom, Stress or Frustration.

• Oral health condition information :-

Table 14. Frequencies and percentages of questions related to oral health condition information.

Oral health condition		No	Yes	Total
Is there an inflammation?	N	309	40	349
	%	88.54	11.46%	100%
		Upper	Lower	Total
If the answer is yes, in which	N	10	30	40

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jaw	%	25%	75%	100%
		<b>No</b>	<b>Yes</b>	<b>Total</b>
Are inflammations in all teeth?	<i>N</i>	297	5	302
	%	98.34%	1.66%	100%
		<b>No</b>	<b>Yes</b>	<b>Total</b>
Is there teeth decay?	<i>N</i>	189	158	347
	%	54.46%	45.54%	100%
		<b>Milk</b>	<b>Permanent</b>	<b>Total</b>
If yes in any teeth	<i>N</i>	101	62	163
	%	61.96%	38.04%	100%
		<b>No</b>	<b>Yes</b>	<b>Total</b>
Are the milk teeth still there?	<i>N</i>	145	176	321
	%	45.17%	54.83%	100%

Table (14) presents the frequencies for answers of survey participants regarding to questions of tooral health condition information.

**Is there an inflammation?**

From Table 14, it is clear that the number of students who answered no, was (309, 88.54%), while the number of students who answered yes, was (40, 11.46%).

**Is there an inflammation? If the answer is yes, in which jaw**

From Table 14, the number of students who answered that inflammation is in the upper jaw was, (10, 25%), while the students who answered that inflammation is in the lower jaw was (30, 75%).

**Are inflammations in all teeth?**

From Table 14, it is clear that the number of students who answered no, was (297, 98.34%), while the number of students who answered yes, was (5, 1.66%).

**Is there teeth decay?**

From Table 14, the number of students who answered no, was (189, 54.46%), while the students who answered yes was (158, 45.54%).

**Is there teeth decay? If yes in any teeth**

From Table 14, the number of students who answered that the decay in milk teeth was, (101, 61.96%), while the students who answered that the decay in permanent teeth was (62, 38.04%).

**Are the milk teeth still there?**

From Table 14, the number of students who answered no, was (145, 45.17%), while the students who answered yes was (176, 54.83%).

- **Information about the state of health of the case in general**

**Table 15.** Frequencies and percentages of questions related to Information about the state of health of the case in general.

Student's health condition	No		Yes		Total (N)
	N	%	N	%	
Does he suffer from any disease?	312	92.58%	25	7.42%	337
Does the student take medication?	231	92.03%	20	7.97%	251

Table (15) shows that most of the students in the sample (312, 92.58%) answered no on the question "**Does he suffer from any disease?**", in contrast, students who answered yes were (25, 7.42%) of the sample members. Moreover, regarding the question "**Does the student take medication?**" we found that about (231, 92.03%) answered no and (20, 7.97%) answered yes. However, Table (16) shows some of the diseases that the students suffer from in the study sample, in addition to some of the medications they take.

**Table 16.** Some of the diseases that the students suffer from and some of the medications they take.

Does he suffer from any disease? If the answer is yes, what is it	
Type of disease	N
Stuttering	3
Chest allergy	17
Nephritis	1
Neurological disease	1

Eczema	1
Eyes sensitivity	1
Diabetes	1
<b>Total</b>	<b>25</b>
Does the student take medication? If yes, what are they?	
Nitrogen	1
Medical spray	14
Antibiotic	1
Nerve medicine	1
Moisturizer	1
Eye drop	1
Insulin	1
<b>Total</b>	<b>20</b>

## DISCUSSION

Nail biting is considered by some to be a variant of normal tactile and environmental exploration. However, it should be noted that this behavior causes physical damage and distress as well as a motivation to change, and therefore cannot be considered benign in children. NB is usually associated with psychiatric disorders in this clinical sample. One explanation is that although NB might be associated with anxiety and functions as a tension reduction behavior, this tension and anxiety may be secondary to another psychiatric disorder such as ADHD and its consequences. Affected patients are aware of their habit and admit their continual nail biting, but they seem unable to control it. It is not possible to determine whether the presence of co-morbid psychiatric disorders is a cause or a consequence of NB.

Onychophagia is reported to be a difficult behavior to modify and the treatment results are not as impressive as initially reported.[20]

Furthermore, research has shown that drugs are not effective for treatment of nail biting and habit reversal techniques are not effective in the long term (7).

Habit-tic nail deformity is a distinctive condition. It can occur in children; however, it is commonly observed in adults. The affected individual usually performs the nail-focused repetitive behavior

subconsciously and is therefore unaware that they are causing their nail dystrophy [1,2,12].

Habit-tic nail deformity can occur on any digit; however, it most commonly appears on one or both thumbnails. It develops from the repeated manipulation (by rubbing or picking) of the affected digit's cuticle, proximal nail fold, or both. The consequence of the habitual contact results in trauma to the underlying nail matrix and manifests as a

[1,2,12] dystrophic nail

Nail-associated body-focused repetitive behaviors occur not only as a solitary obsessive-compulsive condition but also concurrently with other body-focused repetitive behaviors of the hair and skin.[1,3,9,10]

To date, several treatments have been developed in order to treat onychophagia. However nail biting remains an unsolved problem in medicine and dentistry .[2]

Among the treatment options available today, the psychological aspect and the dermatological side effects of such an oral habit both remain the major therapeutic focus.[13 ،2]

Nail biting is genuinely a sequence of 4 distinct phases. Once the finger has been inspected visually or felt by palpation by another finger, the hands are then placed close to the mouth. Subsequently, the mandible is placed in a laterotrusive (or just lateral) edge-to-edge contact position; then, the fingers are quickly tapped against the front teeth followed by a series of quick spasmodic biting actions. In this case the patient will have his fingernails pressed tightly against the biting edges of the teeth. And finally the fingers are withdrawn from the mouth.[2]

Literature revealed that environmental organisms can be inoculated into the oral cavity through paranormal habits like nail biting resulting in transmission of infections to other parts of the body, by contaminated hands or environmental objects, which may be responsible for the cause of morbidity and mortality worldwide(16)

### Conclusion

The incidence of nail biting in TripoliLibya , was most were boys at a rate of 59.5%, and the highest percentage was in the age of 9-12, at a rate of 51.7%, and the highest percentage in the academic level was excellent at 47%. These cases are not hereditary, with a percentage of 85.5%, and

the use of both hands by 65.68%, and the biting of the ten fingers by 54.68%. the is due to boring by 69.2% case detection there were 45.5% caries cases. Most of them are in milk teeth, with a rate of 54.83%.

Nail biting can be a chronic and debilitating habit that may continue into adulthood and can be a source of disease, but it can contribute to severe psychosocial distress. In such cases, we need to educate people, stimulate good habits, and develop awareness when thinking that When considering that nail biting can transmit deadly disease, breaking this habit can be lifesaving

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## Existence of solution for a first order differential Equation with deviated nonlocal condition

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### Abstract:

In this paper, by using the Schauder fixed point theorem we study the existence of the solution of the nonlocal problem of the first order differential equation with deviated nonlocal condition. As application we discuss the solution of the first differential equation with nonlocal integral condition.

### المخلص

هدفنا في هذا البحث إثبات وجود علي الأقل حل واحد لمسألة القيمة الحدية غير المحلية للمعادلة التفاضلية من الرتبة الأولى ذات الشرط غير المحلي الداخلي باستخدام نظرية النقطة الثابتة لشوذر. أيضا استنتاج وجود حل لمسألة القيمة الحدية مع الشرط التكاملية.

**Keywords:** Differential equation, deviated nonlocal condition, integral condition, Schauder fixed point theorem, existence of solution.

### 1. Introduction:

The nonlocal boundary value problems of ordinary differential equations arise in a variety of different areas of applied mathematics and physics.

The study of nonlocal boundary value problems was initiated by Il'in and Moiseev [6] and [7]. Since then, for the nonlocal boundary value problems have been studied by several authors considered in ([1], [3]- [4], [9]-[10]) and and refernces therein.

In [10], authors studied the existence of continuous solution of the nonlocal problem

$$x''(t) = f(t, x(t)), t \in (0, 1)$$

with the local and the deviated nonlocal conditions

$$x'(0) = 0, \alpha x(\phi(\tau)) = x_0 > 0, \alpha > 0,$$

where  $\tau \in (d, 1) \subset (0, 1)$  and  $\phi$  is deviated given function.

Our for the nonlocal problem of the first order differential equation aim here is to study the existence of

$$x'(t) = f(t, x(t)), t \in (0, 1) \quad (1)$$

with the deviated nonlocal condition

$$\sum_{k=1}^m a_k x(\phi(\tau_k)) = x_0. \quad (2)$$

Where  $a_k > 0$ ,  $\tau_k \in (d, 1) \subset (0, 1)$  and  $\phi$  is deviated given function.

As application, the nonlocal problem of (1) with integral condition

$$\int_d^1 x(\phi(s)) ds = x_0. \quad (3)$$

will be studied.

## 2. Preliminaries:

In this section we give some basic notations and theorems which will be used in this paper.

Let  $C[0, 1]$  denotes the class of continuous functions on the interval  $[a, b]$

and  $L^1[a, b]$  denotes

the class of Lebesgue functions on the interval  $[a, b]$ .

### Theorem 1 (Arzela – Ascoli Theorem [5]):

Let  $E$  be a compact metric space and  $C(E)$  be the Banach space of real or complex valued continuous functions normed by

$$\|f\| = \sup_{t \in E} |f(t)|$$

If  $A = \{f_n\}$  is a sequence in  $C(E)$  such that  $f_n$  is uniformly bounded and equicontinuous, then the closure of  $A$  is compact .

### Theorem 2 (Lebesgue Dominated Convergence Theorem[5]):

Let  $\{f_n\}$  be a sequence of functions converging to a limit  $f$  on  $A$ , and suppose that

$$|f_n(t)| \leq \phi(t), t \in A, n = 1, 2, 3, \dots,$$

Where  $\phi$  is integrable on  $A$ , then

$$f \text{ is integrable on } A \text{ and } \lim_{n \rightarrow \infty} \int_A f_n(t) d\mu = \int_A f(t) d\mu.$$

**Theorem 3 (Schauder fixed point theorem[8]):**

Let  $E$  be a Banach space and  $Q$  be a closed, convex subset of  $E$ , and  $F: Q \rightarrow Q$  is compact, continuous map, then  $F$  has at least one fixed point in  $Q$ .

**3. Existence of the solution:**

Consider the first order differential equation (1) with the deviated nonlocal condition (2) with the following assumptions:

is measurable in  $t \in [0, 1]$  for all  $x \in \mathbb{R}^+$  and continuous in  $x \in \mathbb{R}^+$

(i)  $f: [0, 1] \times \mathbb{R}^+ \rightarrow \mathbb{R}^+$

for almost all  $t \in [0, 1]$  and there exist an integrable function  $m \in L^1[0, 1]$  such that

$$|f(t, x)| \leq m(t), \forall (t, x) \in [0, 1] \times D, D \subseteq \mathbb{R}^+.$$

(ii)  $\varphi: (0, 1) \rightarrow (0, 1); \varphi(t) \leq t$  is a deviated continuous function.

(iii)  $\int_0^1 m(s) ds \leq M$ .

Now, we have the following lemma.

**Lemma1:**

If the solution of the nonlocal problem (1)-(2) exist, then it can be expressed by the integral equation

$$x(t) = \frac{1}{\sum_{k=1}^m a_k} \left[ x_0 - \sum_{k=1}^m a_k \int_0^{\varphi(\tau_k)} f(s, x(s)) ds \right] + \int_0^t f(s, x(s)) ds \quad (4)$$

**Proof:**

Integrating equation (1), we get

$$x(t) = x(0) + \int_0^t f(s, x(s)) ds. \quad (5)$$

Let  $t = \varphi(\tau_k)$ , in (5), we get

$$\sum_{k=1}^m a_k x(\varphi(\tau_k)) = \sum_{k=1}^m a_k x(0) + \sum_{k=1}^m a_k \int_0^{\varphi(\tau_k)} f(s, x(s)) ds.$$

And

$$x(0) = \frac{1}{\sum_{k=1}^m a_k} \left[ x_0 - \sum_{k=1}^m a_k \int_0^{\varphi(\tau_k)} f(s, x(s)) ds \right] \quad (6)$$

Substitute from (6) into (5), we obtain (4).

**Theorem 4:**

Let the assumptions (i)-(iii) be satisfied. Then the nonlocal problem (1)-(2) has a solution  $x \in C[0, 1]$ .

**Proof:**

Define the subset  $Q_r \subset C[0, 1]$  by

$$Q_r = \left\{ x: |x(t)| \leq r, r = \frac{1}{\sum_{k=1}^m a_k} x_0 + 2M, r > 0 \right\}.$$

Clear the set  $Q_r$  is nonempty, closed, convex.

Let  $F: Q_r \rightarrow Q_r$  be an operator defined by

$$(Fx)(t) = \frac{1}{\sum_{k=1}^m a_k} \left[ x_0 - \sum_{k=1}^m a_k \int_0^{\varphi(\tau_k)} f(s, x(s)) ds \right] + \int_0^t f(s, x(s)) ds,$$

Let  $x \in Q_r$ , then  $\varphi(t) \leq t$ , we obtain

$$\begin{aligned} |(Fx)(t)| &= \left| \frac{1}{\sum_{k=1}^m a_k} \left[ x_0 - \sum_{k=1}^m a_k \int_0^{\varphi(\tau_k)} f(s, x(s)) ds \right] + \int_0^t f(s, x(s)) ds \right| \\ &\leq \frac{1}{\sum_{k=1}^m a_k} x_0 + \int_0^{\varphi(\tau_k)} |f(s, x(s))| ds + \int_0^t |f(s, x(s))| ds \\ &\leq \frac{1}{\sum_{k=1}^m a_k} x_0 + \int_0^{\tau_k} m(s) ds + \int_0^t m(s) ds \end{aligned}$$

$$\begin{aligned} &\leq \frac{1}{\sum_{k=1}^m a_k} x_0 + \int_0^1 m(s) ds + \int_0^1 m(s) ds \\ &\leq \frac{1}{\sum_{k=1}^m a_k} x_0 + 2M \\ &\leq r. \end{aligned}$$

Then  $\{(Fx)(t)\}$  is uniformly bounded in  $Q_r$ .

Let  $x \in Q_r$  and  $t_1, t_2 \in [0, 1]$ , such that  $t_1 < t_2$ , we have

$$\begin{aligned} (Fx)(t_2) - (Fx)(t_1) &= \frac{1}{\sum_{k=1}^m a_k} \left[ x_0 - \sum_{k=1}^m a_k \int_0^{\varphi(\tau_k)} f(s, x(s)) ds \right] + \int_0^{t_2} f(s, x(s)) ds \\ &\quad - \frac{1}{\sum_{k=1}^m a_k} \left[ x_0 - \sum_{k=1}^m a_k \int_0^{\varphi(\tau_k)} f(s, x(s)) ds \right] - \int_0^{t_1} f(s, x(s)) ds \\ &= \int_0^{t_2} f(s, x(s)) ds - \int_0^{t_1} f(s, x(s)) ds \\ &= \int_{t_1}^{t_2} f(s, x(s)) ds. \end{aligned}$$

$$\begin{aligned} \text{Then } |(Fx)(t_2) - (Fx)(t_1)| &\leq \int_{t_1}^{t_2} |f(s, x(s))| ds \\ &\leq \int_{t_1}^{t_2} m(s) ds. \end{aligned}$$

And we obtain  $|(Fx)(t_2) - (Fx)(t_1)| \rightarrow 0$  as  $t_2 \rightarrow t_1$ .

Hence the class of functions  $\{(Fx)(t)\}$  is equicontinuous. From Arzela–Ascolis' Theorem [5] we deduce that the class of functions  $\{(Fx)(t)\}$  is compact.

Now, we prove that  $F$  is continuous operator.

For  $x \in Q_r$ , let  $\{x_n(t)\} \subset Q_r$  be a convergent sequence such that  $x_n(t) \rightarrow x(t)$ , then

$$Fx_n(t) = \frac{1}{\sum_{k=1}^m a_k} \left[ x_0 - \sum_{k=1}^m a_k \int_0^{\varphi(\tau_k)} f(s, x_n(s)) ds \right] + \int_0^t f(s, x_n(s)) ds$$

and,

$$\lim_{n \rightarrow \infty} Fx_n(t) = \frac{1}{\sum_{k=1}^m a_k} \left[ x_0 - \sum_{k=1}^m a_k \lim_{n \rightarrow \infty} \int_0^{\varphi(\tau_k)} f(s, x_n(s)) ds \right] + \lim_{n \rightarrow \infty} \int_0^t f(s, x_n(s)) ds$$

From assumption (i), we have

$$|f(s, x(s))| \leq m(s) \quad \text{and}$$



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$$f(s, x_n(s)) \rightarrow f(s, x(s)).$$

Applying Lebesgue dominated convergence Theorem [5], we have

$$\begin{aligned} \lim_{n \rightarrow \infty} (Fx_n)(t) &= \frac{1}{\sum_{k=1}^m a_k} \left[ x_0 - \sum_{k=1}^m a_k \int_0^{\varphi(\tau_k)} \lim_{n \rightarrow \infty} f(s, x_n(s)) ds \right] + \int_0^t \lim_{n \rightarrow \infty} f(s, x_n(s)) ds \\ &= \frac{1}{\sum_{k=1}^m a_k} \left[ x_0 - \sum_{k=1}^m a_k \int_0^{\varphi(\tau_k)} f(s, \lim_{n \rightarrow \infty} x_n(s)) ds \right] + \int_0^t f(s, \lim_{n \rightarrow \infty} x_n(s)) ds \\ &= \frac{1}{\sum_{k=1}^m a_k} \left[ x_0 - \sum_{k=1}^m a_k \int_0^{\varphi(\tau_k)} f(s, x(s)) ds \right] + \int_0^t f(s, x(s)) ds \\ &= (Fx)(t). \end{aligned}$$

Hence  $F: Q_r \rightarrow Q_r$  is continuous.

Since all conditions of Schauder fixed point theorem [8], be hold, then  $F$  has a fixed point in  $Q_r$  which proves that there exist a solution  $x \in C[0, 1]$  of the integral equation (4), where

$$\begin{aligned} \lim_{t \rightarrow 0^+} x(t) &= \frac{1}{\sum_{k=1}^m a_k} \left[ x_0 - \sum_{k=1}^m a_k \int_0^{\varphi(\tau_k)} f(s, x(s)) ds \right] = x(0). \\ \lim_{t \rightarrow 1^-} x(t) &= \frac{1}{\sum_{k=1}^m a_k} \left[ x_0 - \sum_{k=1}^m a_k \int_0^{\varphi(\tau_k)} f(s, x(s)) ds \right] + \int_0^1 f(s, x(s)) ds = x(1). \end{aligned}$$

To complete the proof, we prove that the integral equation (4) satisfies the problem (1)-(2).

Differentiating (4), we get

$$\begin{aligned} x'(t) &= \frac{d}{dt} \int_0^t f(s, x(s)) ds, \\ &= f(t, x(t)). \end{aligned}$$

Letting  $t = \varphi(\tau_k)$  in (4), we obtain

$$x(\varphi(\tau_k)) = \frac{1}{\sum_{k=1}^m a_k} \left[ x_0 - \sum_{k=1}^m a_k \int_0^{\varphi(\tau_k)} f(s, x(s)) ds \right] + \int_0^{\varphi(\tau_k)} f(s, x(s)) ds.$$

Then  $\sum_{k=1}^m a_k x(\varphi(\tau_k)) = x_0$ ,  $\tau_k \in (d, 1)$ .

This implies that there exist a solution  $x \in C[0, 1]$  of the problem (1)-(2).

#### 4. Nonlocal integral condition:

##### Theorem 5

Let the assumptions (i)-(iii) be satisfied. Then there is a solution  $x \in C[0, 1]$  of (1) with integral condition (3) and this solution is given by

$$\text{Proof } x(t) = \frac{1}{1-d} [x_0 - \int_d^1 \int_0^{\varphi(t)} f(s, x(s)) ds dt] + \int_0^t f(s, x(s)) ds.$$

$$\text{Let } a_k = t_k - t_{k-1}, \tau_k \in (t_{k-1}, t_k) \subset (d, 1) \subset (0, 1).$$

Then the nonlocal condition (2) will be

$$\sum_{k=1}^m (t_k - t_{k-1}) x(\varphi(\tau_k)) = x_0, \quad \sum_{k=1}^m a_k = 1 - d.$$

$$\text{And } \lim_{m \rightarrow \infty} \sum_{k=1}^m (t_k - t_{k-1}) x(\varphi(\tau_k)) = \int_d^1 x(\varphi(s)) ds.$$

Therefore, as  $m \rightarrow \infty$ , the solution of the nonlocal problem (1)-(3) can be expressed as follows:

$$\begin{aligned} x(t) &= \lim_{m \rightarrow \infty} \frac{1}{\sum_{k=1}^m a_k} [x_0 - \sum_{k=1}^m a_k \int_0^{\varphi(\tau_k)} f(s, x(s)) ds] + \int_0^t f(s, x(s)) ds \\ &= \frac{1}{1-d} [x_0 - \lim_{m \rightarrow \infty} \sum_{k=1}^m (t_k - t_{k-1}) \int_0^{\tau_k} f(s, x(s)) ds] + \int_0^t f(s, x(s)) ds \\ &= \frac{1}{1-d} [x_0 - \int_d^1 \int_0^{\varphi(t)} f(s, x(s)) ds dt] + \int_0^t f(s, x(s)) ds. \end{aligned}$$

**Conclusion:**

In this paper, by using the Schauder fixed point theorem, we proved the existence of solution for the first order differential equation with deviated nonlocal condition. Generalization for the nonlocal condition (2) to (3) has been proved.

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