

Study of the Demographic and Clinical Profile in a Neurocutaneous Rare Disease: A Cross-Sectional Study

Leila Jouybari¹, Samira Foji², Akram Sanagoo³, Morteza oladenabidozin⁴, Ali yazdani⁵

Abstract

Objective: Neurofibromatosis is one of the most common dominantly inherited genetic disorders. This study aimed to study the demographic and clinical profile of neurofibromatosis patients.

Methods: This study is cross-sectional conducted in 2020 on the population of patients with neurofibromatosis. Patients who are members of the Neurofibromatosis Association answered the online demographic and clinical information questionnaire.

Results: 446 patients with neurofibromatosis participated in this study with a mean age of 33.39 ± 12.87 years. 297 patients (66.6%) were women and 378 (84.8%) patients had type 1 neurofibromatosis. The disease visibility was reported to be moderate in 254 patients (54.9%) and the severity of the disease was mild in 238 (53.4%) patients. The type of neurofibromatosis was not significantly related to gender, age groups, parental education, and ethnicity. The relationship between severity and age ($p = <0.001$) and gender ($p = 0.042$) was significant and the relationship between visibility and age ($p = <0.001$) was significant but despite the fact that the disease was more visible in men than women, it was not significantly related to gender.

Conclusions: The study results showed that the most common complication in the study population was Café au lait spot. In addition, visibility and severity of the disease were mild and moderate, respectively.

Keyword: Neurofibromatosis, Demographic information, Clinical Information.

Acta Neurol Taiwan 2022;31:15-23

INTRODUCTION

Neurofibromatosis is a genetic disease of the central

and peripheral nervous system that is inherited with a predominant autosomal pattern. The more common

From the Department of ¹PhD in Nursing, Associate Professor, Nursing Research Center, Golestan University of Medical Sciences, Gorgan, Iran; ²PhD in Nursing, Assistant Professor, Sabzevar University of Medical Sciences, Sabzevar, Iran; ³PhD in Nursing, Associate Professor, School of Nursing and Midwifery, Golestan University of Medical Sciences, Gorgan, Iran; ⁴PhD in Medical Genetics, Assistant Professor, Gorgan Congenital Malformations Research Center, Golestan University of Medical Sciences, Gorgan, Iran; ⁵Assistant Professor, Anesthesiologist, Faculty member of Sabzevar University of Medical Sciences, Sabzevar, Iran

Received May 18, 2021. Revised September 15, 2021.

Accepted September 16, 2021.

Correspondence to: Samira Foji, Sabzevar University of Medical Sciences, sabzevar, Iran. Email: sfoji@mail2world.com

type of the disease, type 1 neurofibromatosis, occurs with a prevalence of one in every 3000 to 4000 births⁽¹⁾. Neurofibromatosis is the most common neurocutaneous syndrome. The disease is progressive and unpredictable, and its symptoms vary. The severity of symptoms may range from mild beauty damage to life-threatening conditions⁽²⁾.

The most common clinical manifestations in these patients are hyper-pigmented skin lesions (Café au lait spot), neurocutaneous neurofibromatosis, Lisch nodule, and learning difficulties. Optical gliomas and other malignancies and malignant tumors of the nerve sheath and bone lesions are also less common⁽³⁾.

Neurofibromatosis is a chronic disease and chronic and life-threatening diseases are among the most stressful factors in humans that affect a person's identity, psychosocial dimensions, emotional balance, self-satisfaction, sense of competence and efficiency, social interaction, and interpersonal relationships. Individuals with chronic diseases should meet the challenges for achieving an acceptable level of health, physical, mental and social functioning⁽⁴⁾. One of the psychological aspects of living with neurofibromatosis is a high level of concern about the condition and the unpredictable progression of the disease. Visible neurofibromatosis causes significant concern, especially in young women, and low self-esteem⁽⁴⁾. Low self-esteem and other psychological problems can be the result of childhood experiences of learning disabilities and failure at school⁽⁶⁾. About 20% of patients with skin diseases suffer from bad moods and 7% of patients suffer from depression and commit suicide⁽⁷⁾. The patients with neurofibromatosis also have mental disorders, anxiety, personality disorders, depression, and suicide attempts⁽⁸⁾. Cognitive impairment may persist into adulthood and affect a person's job performance, hence impairing the quality of life completely in patients with neurofibromatosis, especially in severe cases⁽⁹⁾. The patients with neurofibromatosis are also at risk for various tumors and have a lower life expectancy than the general population of 10 years⁽¹⁰⁾. Although skin lesions are the most significant manifestation of neurofibromatosis, there is a possibility of involvement of other organs and cancer⁽¹¹⁾. Due to the rarity and the prevalence of the disease in the country and the lack of a database⁽¹²⁾ access to clinical information and demographics of

neurofibromatosis helps to provide comprehensive care to patients with codified planning. Accordingly, the present study was conducted for the first time in the country to determine the demographic and clinical information of patients with neurofibromatosis.

MATERIAL AND METHODS

This cross-sectional study was conducted in 2020 in population patients with neurofibromatosis. The sampling method was non-random and convenient. 446 patients with neurofibromatosis with the study inclusion criteria participated in the study. The study inclusion criteria were suffering from neurofibromatosis. Regarding the rarity of neurofibromatosis and the unavailability of patients in coordination with the Neurofibromatosis Support Association, the questionnaires were designed online. The participants completed the questionnaire online through the website. The patients were asked to complete an online questionnaire form for other affected family members who were unable to fill out an online form. Data collection tools included demographic information collection forms with questions such as age, gender, education, occupation, ethnicity, and etc., and clinical information including disease type, common signs and symptoms of the disease, severity, and visibility of the disease. Informed consent was obtained from all participants regarding their participation in the research by expressing the purpose, nature, and method of study. Participants were assured of the confidentiality of their information files. Percentage, frequency, mean, Chi-Square test, Fisher test, Cramer V coefficient, and Kruskal-Wallis test were used to report demographic and clinical information. The data were analyzed using software SPSS version 24.

RESULTS

The study was conducted on 446 patients with neurofibromatosis. The mean age was 33.39 years at a confidence interval of 32.19 to 34.60. 297 (66.6%) patients were female. In all three types of disease, the majority of participants were women (NF1(69.8), NF2(66.7), SCHW(50)). The study results of demographic information of patients are as follows (Table 1).

The study population in 8 regions of the country

is as follows: North 49 (11.1) patients, Northwest 16 (3.6) patients, Northeast 43 (9.8) patients, West 30 (6.8) patients, Central 236 (53.5) patients, Southwest 56 (12.7) patients, Southeast 9 (2) patients, South 2 (0.5) patients (Figure 1).

Parents of patients with neurofibromatosis often had Fars ethnicity and high school education level (Table 2).

Clinical information of neurofibromatosis patients showed that type 1 (84.8) is more common in the study population. The first symptoms are more pronounced in the abdomen. The disease severity was often mild (53.4) and visibility in most cases was moderate (54.9) (Table3).

The study results of common symptoms in patients with neurofibromatosis showed that the most common symptoms in patients with neurofibromatosis were Café au lait spot (95.5), neurocutaneous neurofibroma (86.3), and freckles (78.3) (Table 4).

No significant relationship was found between type of neurofibromatosis with gender and age ($p = 0.743$) ($p = 0.593$). The distribution of the type of disease with gender and age is shown in Table 5.

In order to determine the relationship between the number of patients with the disease in the family and the education of the parents, it was first determined that plots were not normalized using $p < 0.0001$, so using the Kruskal-Wallis test no significant relationship was

found between the number of patients in the family and the education of the parents (father education $p = 0.901$ and mother education $p = 0.507$). Also, no significant

Table1: Demographic information of neurofibromatosis patients

Demographic information of patient	N(%)
Gender	
Male	149(33.5)
Female	296(66.5)
Age (years)	
1-17	49(11.1)
18-35	208(47.2)
36-55	160(36.3)
>56	24(5.4)
Marital statuses	
Single	282(38.7)
Married	148(20.3)
Divorced	16(2.2)
Job	
Worker	37(8.3)
Employee	65(14.6)
Freelance job	70(15.7)
Housewife	95(14.6)
Retired	18(4)
Unemployed	161(36.1)

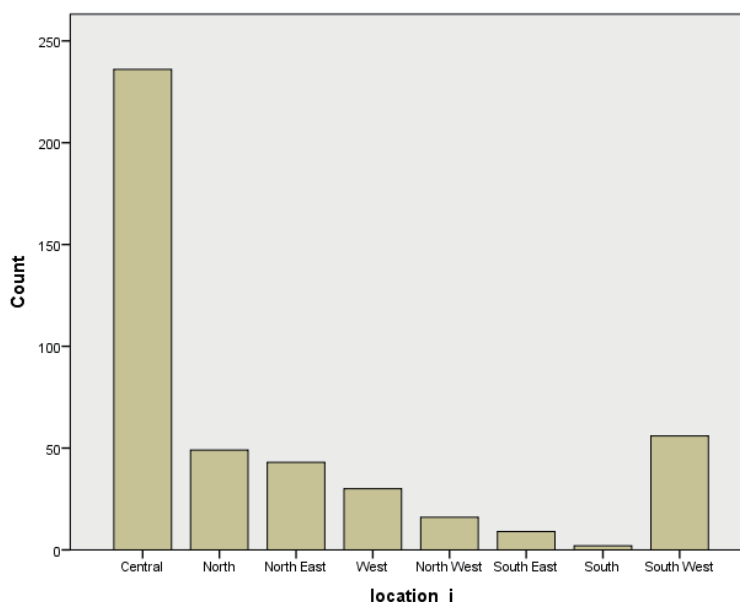


Figure 1. Study population in 8 regions of Iran

Table 2: Parental Demographic Information of Neurofibromatosis Patients

Demographic information of Parents		
Parental ethnicity	Father N(%)	Mather N(%)
Fars	287(64.3)	299(67)
Azary	72(16.1)	66(14.8)
kord	28(6.3)	27(6.1)
lor	39(8.7)	37(8.3)
other	20(4.4)	17(3.7)
Parental education		
illiterate	110(24.7)	132(29.6)
Elementary	135(30.3)	126(28.3)
High school	137(30.7)	134(30)
Academic	64(14.3)	54(12.1)

Table 3: Clinical information of patients with neurofibromatosis

Clinical Information	N(%)
Type of neurofibromatosis	
NF1	378(84.8)
NF2	6(1.3)
SCHW	4(0.9)
The first organ symptom appeared	
Face	61(13.7)
Hand	62(13.9)
Foot	53(11.9)
Abdominal	151(33.9)
Back	98(22)
Head	21(4.7)
Genetic testing	
Yes	64(14.3)
No	380(85.2)
Visibility (Ablon scale)	
Mild	151(33.9)
Moderate	254(54.9)
Severe	50(11.2)
Severity (with Riccardi scale)	
Minimal	54(12.1)
Mild	238(53.4)
moderate	114(25.6)
severe	40(9)

relationship was found between ethnicity and type of disease using Fisher's exact test ($p = 0.191$).

A significant relationship was found between age and severity of disease using the X^2 test ($p = <0.001$) so that the severity of the disease increases with age. Also, a significant relationship between the severity of the disease and gender ($p = <0.001$) so the Cramer V test coefficient was 0.136. The severity of the disease was higher in men than in women. No significant relationship was found between lesion visibility and gender using the Ablon scale ($p = 0.445$). Also, a significant relationship was found between age and visibility of lesions using the Ablon scale ($p = <0.001$) (Table6).

DISCUSSION

Recording rare diseases is an important part of clinical research efforts aimed to further understand the clinical signs and demographics of rare diseases. Since the variety of clinical symptoms in patients with neurofibromatosis is high⁽¹³⁾, the identification of predictors that affect health outcomes in patients with NF1 requires the gathering of a large number of individuals for clinical epidemiological research. Given that the study in Iran has not yet examined demographic and clinical information of neurofibromatosis patients⁽¹²⁾, the purpose of this study was to investigate demographic and clinical information of patients with neurofibromatosis in Iran. In this study, most of the participants had type 1 neurofibromatosis.

Table 4: Type and frequency of complications detected.

Percentage and frequency of symptoms of the disease	YES	NO
	N(%)	
Latte Cafe Stains	426(95.5)	20(4.5)
Freckles in the armpits or groin	349(78.3)	97(21.7)
Soft bumps on or under the skin (neurofibroma)	385(86.3)	61(13.7)
Tumors inside the body	207(46.4)	239(53.6)
Tumor inside the spine	81(18.2)	365(81.8)
Tumors inside the brain	66(14.8)	380(85.2)
Plexiglas masses form	142(31.8)	304(68.2)
Spinal Deviation (Sclerosis)	74(16.6)	372(83.4)
Soft bones (feet or hands)	44(9.9)	402(90.1)
Sloping hands and feet	58(13)	388(87)
Inability to learn (difficulty memorizing, or reading and writing)	98(22)	348(78)
Stains on the iris of the eye	127(28.5)	319(71.5)
Tumor on the optic nerve (optic glioma)	48(10.8)	398(89.2)
Small size / short stature	106(23.8)	340(76.2)
Body pain	202(45.3)	244(54.7)
Headache	212(47.5)	234(52.5)
seizer	31(7)	415(93)
Hearing loss	62(13.9)	384(86.1)
Deafness	14(3.1)	432(96.9)
Ringing in the ears	110(24.7)	336(75.3)
Balance problems and poor walking balance	63(14.1)	383(85.9)
Falling face	55(12.3)	391(87.7)
Blindness	17(3.8)	429(96.2)
Cataract (cataract)	17(3.8)	429(96.2)
Schwannomatosis tumor	18(4)	428(96)

In a study by Seidlin (2017), the highest percentage of patients had type 1, then type 2, and Schwannomatosis⁽¹⁴⁾. The prevalence of type 1 neurofibromatosis in the world is expected to be one in every 3,000 births, the prevalence of type 2 neurofibromatosis is two out of every 30,000 births, and the prevalence of Schwannomatosis is 1 out of every 40,000 births^(15,16). Most of the participants in this study were women. In other studies, women were more involved in health-related research^(17,18). The most common clinical symptoms in the present study reported in 446 patients were Café au lait spot (95.5%), Neurofibroma (86.3%), freckles (78.3%), and pain (47.5%). In a study by Noble et al. (2007), Café au lait spot (99%), Freckles (90%), Neurofibroma (84%), Lisch nodule (70%), skeletal

lesions (14%), and optic glioma (4%) were common, respectively⁽¹⁹⁾, Ferner (2007) also reported that the most common symptoms in more than 99% of patients with neurofibromatosis were Café au lait spot and neurofibroma⁽²⁰⁾. Bata (2019) also repeated that 98% of patients had Café au lait spots as more common symptoms⁽²¹⁾.

The disease visibility in the population participating in this study was moderate, which was consistent with the study results of Page (2006). In the present study, the severity of the disease was reported to be mild. In a study by Page (2006), the severity of the disease on the 4-option Riccardi scale was minimum (34%); mild (26%); moderate (34%); severe (0.6%), which was minimal and moderate were the highest percentage of disease severity

Table 5: Enrollment by type of NF with age and sex.

Gender	Type of neurofibromatosis			
	NF1	NF2	SCHW	Total
Male	114(96.6)	2(1.7)	2(1.7)	118(100)
Female	263(97.8)	4(1.5)	2(0.7)	269(100)
Total	377(97.4)	6(1.6)	4(1)	387(100)
Fishers exact test: 0.743				
Age(year)	NF1	NF2	SCHW	Total
1-17	42(100)	0	0	42(100)
18-35	172(96.6)	5(2.8)	1(0.6)	178(100)
36-55	141(97.2)	1(0.7)	3(2.1)	145(100)
≥56	19(100)	0	0	19(100)
Total	374(97.4)	6(1.6)	4(1)	384(100)
Fishers exact test: 0.593				

Table 6: Enrollment by age and gender with severity and visibility.

Riccardi scale					
Age (year)	Minimal	Mild	Moderate	Severe	Total
1-17	26(53.1)	14(28.6)	6(12.2)	3(6.1)	49(100)
18-35	17(8.2)	120(57.7)	52(25)	19(9.1)	208(100)
36-55	8(5)	93(58.1)	45(28.1)	14(8.8)	160(100)
≥56	2(8.3)	8(33.3)	11(45.8)	3(12.5)	24(100)
Total	53(12)	235(53.3)	114(25.9)	39(8.8)	441(100)
X2: <0.001					
Cramers V: 0.268					
gender	minimal	Mild	moderate	severe	Total
male	21(14.1)	68(45.6)	40(26.8)	20(13.4)	149(100)
female	33(11.1)	170(57.2)	74(24.9)	20(6.7)	297(100)
Total	54(12.1)	238(53.4)	114(25.6)	40(9)	446(100)
X2: 0.042					
Cramers V: 0.136					
Ablon scale					
Gender	Mild	moderate	Severe	Total	
Male	46(30.9)	83(55.7)	20(13.4)	149(100)	
Female	105(35.5)	161(54.4)	30(10.1)	296(100)	
Total	151(33.9)	244(54.8)	50(11.2)	445(100)	
X2: 0.445					
Age(year)	Mild	moderate	Severe	Total	
1-17	37(75.5)	10(20.4)	2(4.1)	49(100)	
18-35	69(33.2)	120(57.7)	19(9.1)	208(100)	
36-55	40(25)	101(63.1)	19(11.9)	160(100)	
≥56	3(12.5)	11(45.8)	10(41.7)	24(100)	
Total	149(33.8)	242(54.9)	50(11.3)	441(100)	
X2: <0.001					
Cramers V: 0.278					

(22).

No significant relationship was found between gender and ethnicity with the type of disease. The results of other studies also show that neurofibromatosis affects all races and both males and females equally⁽²³⁾. No significant relationship was found between age and disease type, which was not consistent with a study by Seidlin et al. (2017)⁽¹⁴⁾. Only 14.3% of patients underwent genetic testing. Neurofibromatosis is diagnosed through genetic testing or clinical signs⁽²⁴⁾. In a study by Mansouri et al. (2017), 39% of patients have undergone the genetic test. The results of the present study showed that using the Riccardi scale, the severity of the disease was significantly related to age and gender, and according to the Ablon scale, to measure the visibility of the disease, it was not significantly related to gender, while with increasing age the visibility rate increased. In a study, Zvulunov et al. (2000) found no significant relationship between age and gender with the severity of the disease⁽²⁵⁾. The results of the present study were inconsistent with the study results of Wolkenstein (2001) in the relationship between age and gender with the severity of the disease so that no relationship was found between age and gender with the severity of the disease⁽²⁶⁾. The reason for this difference could be the sample size participating in the study. The present study was conducted on 446 participants, while a study by Wolkenstein was conducted with a sample size of $n = 128$. Another reason could be the type of patients participating in the study by Wolkenstein conducted only on patients with neurofibromatosis type I, while in the present study patients with type 2 neurofibromatosis were also examined for Schwannomatosis⁽²⁶⁾. The study results of Duong et al. (2011) showed that a reduction in Café au lait spot and an increase in Neurofibroma were significantly associated with increasing age ($p < 0.001$). The reduction in Café au lait spot has been reported for the first time in this study with increasing age, while exacerbation of spots and masses occurs with increasing age and with maturity and pregnancy of patients⁽²⁷⁾. One of the limitations of the study is that some patients do not have access to the Internet as one of the study exclusion criteria. Regarding the rarity of the disease and geographical distribution, data collection using online questionnaires was an inexpensive and convenient method.

CONCLUSIONS

The study results showed that the most common complication in the study population was Café au lait spot. In addition, visibility and severity of the disease were mild and moderate, respectively.

Declarations

Ethics approval and consent to participate

This study was approved by the ethical review boards at the authors' institution. Informed consent was obtained from all participants regarding their participation in the research by clarifying for them the purpose of the study.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Authors' contributions

All authors read and approved the final manuscript.

Acknowledgments

Not applicable

REFERENCES

1. Barke J, Coad J, Harcourt D. Parents' experiences of caring for a young person with neurofibromatosis type 1 (NF1): a qualitative study. *Journal of community genetics*. 2016;7(1):33-9.
2. Dai A, Radtke HB, Knight P, Jordan JT, Plotkin SR, Cannon A. Cutaneous neurofibromas in

- Neurofibromatosis type I: a quantitative natural history study. *BMC health services research*. 2018;13(1):31.
3. Hummelvoll G, Antonsen KM. Young adults' experience of living with neurofibromatosis type 1. *Journal of genetic counseling*. 2013;22(2):188-99.
 4. Klein-Tasman BP, Colon AM, Brei N, van der Fluit F, Casnar CL, Janke KM, et al. Adaptive behavior in young children with neurofibromatosis type 1. *International journal of pediatrics*. 2013;2013.
 5. Graf A, Landolt MA, Mori AC, Boltshauser E. Quality of life and psychological adjustment in children and adolescents with neurofibromatosis type 1. *The Journal of pediatrics*. 2006;149(3):348-53.
 6. Wiener L, Battles H, Bedoya SZ, Baldwin A, Widemann BC. Identifying symptoms of distress in youth living with neurofibromatosis type 1 (NF1). *Journal of genetic counseling*. 2018;27(1):115-23.
 7. Martin S, Wolters P, Baldwin A, Gillespie A, Dombi E, Walker K, et al. Social-emotional functioning of children and adolescents with Neurofibromatosis Type 1 and plexiform neurofibromas: relationships with cognitive, disease, and environmental variables. *Journal of Pediatric Psychology*. 2012;37(7):713-24.
 8. Wang DL, Smith KB, Esparza S, Leigh FA, Muzikansky A, Park ER, et al. Emotional functioning of patients with neurofibromatosis tumor suppressor syndrome. *Genetics in medicine*. 2012;14(12):977-82.
 9. Pasini A, Lo-Castro A, Di Carlo L, Pitzianti M, Siracusano M, Rosa C, et al. Detecting anxiety symptoms in children and youths with neurofibromatosis type I. *American Journal of Medical Genetics Part B: Neuropsychiatric Genetics*. 2012;159(7):869-73.
 10. Rosnau K, Hashmi SS, Northrup H, Slopis J, Noblin S, Ashfaq M. Knowledge and self-esteem of individuals with neurofibromatosis type 1 (NF1). *Journal of genetic counseling*. 2017;26(3):620-7.
 11. Rietman AB, van Helden H, Both PH, Taal W, Legerstee JS, van Staa A, et al. Worries and needs of adults and parents of adults with neurofibromatosis type 1. *American journal of medical genetics Part A*. 2018;176(5):1150-60.
 12. Soghi I, Saeedi S, Sanagoo A, Jouybari L, Ebrahimirad M, Mehravar F. Quality Of Life in a Group of Iranian Patients with Neurofibromatosis Type 1 with Cutaneous Expressions. *Journal of Mazandaran University of Medical Sciences*. 2018;28(162):95-103.
 13. Rieley MB, Stevenson DA, Viskochil DH, Tinkle BT, Martin LJ, Schorry EK. Variable expression of neurofibromatosis 1 in monozygotic twins. *American Journal of Medical Genetics Part A*. 2011;155(3):478-85.
 14. Seidlin M, Holzman R, Knight P, Korf B, Miller VR, Viskochil D, et al. Characterization and utilization of an international neurofibromatosis web-based, patient-entered registry: An observational study. *PLoS one*. 2017;12(6).
 15. Sabbagh A, Pasmant E, Imbard A, Luscan A, Soares M, Blanché H, et al. NF 1 Molecular Characterization and Neurofibromatosis Type I Genotype-Phenotype Correlation: The French Experience. *Human mutation*. 2013;34(11):1510-8.
 16. Messiaen L, Yao S, Brems H, Callens T, Sathienkijanchai A, Denayer E, et al. Clinical and mutational spectrum of neurofibromatosis type 1-like syndrome. *Jama*. 2009;302(19):2111-8.
 17. de Coul ELO, Götz HM, van Bergen JE, Fennema JS, Hoebe CJ, Koekenbier RH, et al. Who participates in the Dutch Chlamydia screening? A study on demographic and behavioral correlates of participation and positivity. *Sexually transmitted diseases*. 2012;39(2):97-103.
 18. Le Retraite L, Eisinger F, Loundou A, Rinaldi Y, Seitz J-F, Auquier P. Sociogeographical factors associated with participation in colorectal cancer screening. *Gastroenterologie clinique et biologique*. 2010;34(10):534-40.
 19. Noble F, Kornberg AJ, Elder JE, Delatycki MB. Retrospective analysis of patients attending a neurofibromatosis type 1 clinic. *Journal of paediatrics and child health*. 2007;43(1-2):55-9.
 20. Ferner RE, Huson SM, Thomas N, Moss C, Willshaw H, Evans DG, et al. Guidelines for the diagnosis and management of individuals with neurofibromatosis 1. *Journal of medical genetics*. 2007;44(2):81-8.
 21. Bata BM, Hodge DO, Mohny BG. Neurofibromatosis Type 1: A Population-Based Study. *Journal of pediatric ophthalmology and strabismus*. 2019;56(4):243-7.
 22. Page PZ, Page GP, Ecosse E, Korf BR, Lepage A, Wolkenstein P. Impact of neurofibromatosis 1

- on Quality of Life: A cross-sectional study of 176 American cases. *American Journal of Medical Genetics Part A*. 2006;140(18):1893-8.
23. Johnson KJ, Hussain I, Williams K, Santens R, Mueller NL, Gutmann DH. Development of an international internet-based neurofibromatosis type 1 patient registry. *Contemporary clinical trials*. 2013;34(2):305-11.
 24. Mansouri A, Ghadakzadeh S, Maqbool T, Barnett C, Au K, Kongkham P, et al. Neurofibromatosis Clinic: A report on patient demographics and evaluation of the clinic. *Canadian Journal of Neurological Sciences*. 2017;44(5):577-88.
 25. Zvulunov A, Weitz R, Metzker A. Neurofibromatosis type 1 in childhood: evaluation of clinical and epidemiologic features as predictive factors for severity. *Clinical pediatrics*. 1998;37(5):295-9.
 26. Wolkenstein P, Zeller J, Revuz J, Ecosse E, Leplège A. Quality-of-life impairment in neurofibromatosis type 1: a cross-sectional study of 128 cases. *Archives of Dermatology*. 2001;137(11):1421-5.
 27. Duong T, Bastuji-Garin S, Valeyrie-Allanore L, Sbidian E, Ferkal S, Wolkenstein P. Evolving pattern with age of cutaneous signs in neurofibromatosis type 1: a cross-sectional study of 728 patients. *Dermatology*. 2011;222(3):269-73.