Original Article

The Strabismus Prevalence in a Random Sample of Iran's Northeastern Population

Akbar Derakhshan[1], Ali Akbar Sabermoghaddam[2], Milad Abdolahian[3], Siamak Zarei Ghanavati[4], Mohammad Taghi Shakeri[5], Mehran Alirezaei[6], Athar Zareei[7], Shahram Bamdad[8]

[1,2,4,5,6]*Mashhad University of Medical Sciences, Mashhad, Iran,*
[3,7,8]*Poostchi Ophthalmology Research Center, Department of Ophthalmology, School of Medicine, Shiraz University of Medical Sciences, Shiraz, Iran*

ABSTRACT

Purpose: To investigate prevalence of strabismus and related factors in Mashhad, Iran.

Study Design: Cross sectional study.

Place and Duration of Study: Khatam-al-Anbia Hospital affiliated with Mashhad University of Medical Sciences.

Methods: Using multistage cluster sampling, participants were selected. All participants underwent detailed ocular examinations. A unilateral cover test was performed with the prism bar to achieve binocular alignment. Deviation magnitude was determined by considering the best refractive correction. Fixation targets were chosen as single letters one line above the best-corrected visual acuity on the distance and near chart.

Results: This study included 5054 participants with a mean age of 35.35±19.4 years. Strabismus was detected in 110 participants (2.17%) including 26 (0.51%) with esodeviation, 74 (1.46%) with exodeviation and 10 (0.19%) with vertical deviation. The prevalence rates for strabismus, exotropia and esotropia were 2.38%, 1.64%, and 0.56% in females and 2.00%, 1.31%, and 0.51% in males respectively. The results did not indicate a significant gender difference in terms of strabismus prevalence (p>0.05). Among the deviated eyes, there were 25.5% with hyperopia, 39.1% with myopia and 35.5% with emmetropia. Anisometropia and amblyopia rates were 2.79% and 2.55%, respectively. The results did not reveal a significant correlation between strabismus prevalence, exotropia and esotropia and age (p=0.56). The familial strabismus prevalence was 5.45%.

Conclusion: Exotropia was more prevalent form of strabismus. Myopia was the dominant refractive error associated with deviated eyes. Tropia showed no age-related association.

Key Words: Strabismus, Prevalence, Esotropia, Exotropia, refractive errors.

How to Cite this Article: Derakhshan A, Sabermoghaddam A, Abdolahian M, Ghanavati SZ, Shakeri MT, Alirezaei M, Zareei A, Bamdad S. The Strabismus Prevalence in a Random Sample of Iran's Northeastern Population. 2024;40(1):34-39. **Doi: 10.36351/pjo.v40i1.1688**

Correspondence to: Shahram Bamdad
Poostchi Ophthalmology Research Center, Department of Ophthalmology, School of Medicine, Shiraz University of Medical Sciences, Shiraz, Iran
Email: shahramdamdad@yahoo.com

INTRODUCTION

Amblyopia is most often caused by strabismus, followed by refractive disorders. Visual disturbances like tropia can have different outcomes such as loss of self-confidence, educational dropout, lack of social and personality development and missing job opportunities.[1] Therefore, determination of prevalence of strabismus is essential for public health as well as for characterizing the extent of disorder to apply appropriate curative and preventive plans in order to

prepare screening and health infrastructures. Prevalence of tropia differs in various ethnicities and countries, ranging from at least 0.80% to a peak of 4.3% in different studies.[2] Studies have reported prevalence rates of 1.2% and 2.3% in Shahroud and Tehran, respectively.[3] The esotropia/exotropia ratio is one of the most critical issues about strabismus. Prevalence of strabismus subtypes varies remarkably among different ethnic categories. For instance, a high percentage of esotropia has been identified in Western countries like Sweden,[4] Non-Hispanic White Americans[5] and Australia.[6] In contrast, exotropia is the dominant strabismus subtype in Asian countries.[7] Moreover, several genetic and environmental factors including anisometropia,[8] intraventricular bleeding, cerebral palsy,[9] maternal cigarette smoking during pregnancy,[9] have shown correlations with strabismus. This study examines strabismus prevalence and its subtypes and determine the effects of some associated factors like refractive error, age, and gender.

METHODS

The study participants were selected using multistage cluster sampling in Mashhad, Iran's second-largest city (Figure 1).
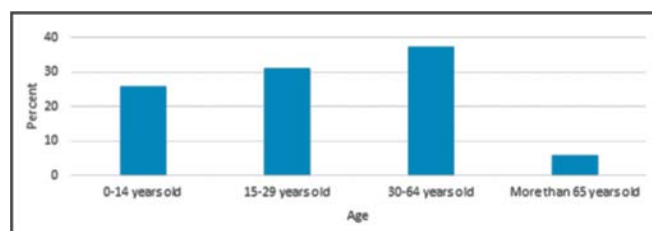

Figure 1: Age distribution of Mashhad population.

A research ethics committee authorized this study at Khatam-al-Anbia Hospital affiliated with Mashhad University of Medical Sciences Throughout the process, all procedures were guided by the principles of Declaration of Helsinki. Prior to the examination, parental and participant consent forms were signed. Demographic information was obtained from all the participants. The patients were given a phone call invitation to take part in the research. All the participants were referred to Khatam-al-Anbia Hospital, affiliated with Mashhad University of Medical Sciences, for detailed examinations, including visual acuity, measurement of the angle of esotropia, exotropia or vertical deviation, refraction and anterior

and posterior segment evaluation. We conducted dry and cycloplegic refraction in every patient. Patient's or parent's unwilling to cooperate, suffering from other ocular anomalies and systemic diseases related to ocular vision and trauma to the brain or eyes were excluded. A Topcon auto-refractometer was used if possible, for auto-refraction (KR-800; Topcon, Tokyo, Japan). Every participant underwent retinoscopy with a HEINE Beta 200 retinoscope. The results were rechecked subjectively in the next step to achieve the best vision sphere and cylinder (magnitude and axis). Prism and alternating-cover tests were conducted at 6m and 40cm with an accommodative target to determine angular deviations. Deviation was recorded with spectacle corrections on. Cover test and Hirschberg light reflex tests were used to assess ocular alignment. Presence of strabismus and its type (exotropia, esotropia and vertical deviation) was recorded, and amount of strabismus (prism diopters) were also measured. The best-corrected visual acuity was determined using a tumbling E chart for individuals below seven years old and the standard Snellen E chart for adults at a 6 m and 40 cm distance. Afterwards, unilateral cover test with prism bar was done to achieve binocular alignment at near and far fixation distance. The deviation magnitude was recorded for each participant separately. Detecting the magnitude of deviation was performed through best addition lenses in presbyopic individuals. The fixation target was chosen as single letter one line above best-corrected visual acuity at distance and near vision chart. Finally, cycloplegic refraction was performed using cyclopentolate 1% eye drops for all participants. Three drops of this agent were administered at five-minute intervals. Thirty minutes after the last instillation, auto refraction was repeated under cycloplegic conditions. Strabismus was described as a constant deviation of the eye at close or distant fixation measured by cover test and was categorized as esotropia, exotropia or vertical tropia. Myopia and hyperopia were defined as spherical equivalent (spherical part of the refractive error + 1/2 value of the cylindrical part) lower than −0.5 D and more than +0.5D, respectively. Unilateral amblyopia was identified as at least two-line difference between the eyes, with the best-corrected visual acuity lower than 20/30 in the worse eye. In comparison, bilateral amblyopia was defined as the best-corrected visual acuity lower than 20/40 in both eyes without any pathology. At least 1.00D difference of the spherical

refraction equivalent between the two eyes was described as anisometropia.

Data were analyzed using SPSS21 software (SPSS Inc., Chicago, Illinois, USA). The normality of the data was assessed using Kolmogorov–Smirnov test, which showed normal distribution of the quantitative data. Multiple logistic regression was used to assess correlation between strabismus and factors as age, gender, and refractive error. P-values less than 0.05 were considered statistically significant.

RESULTS

Out of 5054 participants under investigation, 2744 (54.29%) were male, and 2310 (45.71%) were female. Mean age of the participants was 35.35±19.4 years (range: 6 months to 85 years). We conducted dry and cycloplegic refraction in all participants. The means of cycloplegic and non-cycloplegic spherical equivalents were 0.89±0.92 and −0.47 ± 1.32 D, respectively. Additionally, prevalence of strabismus was 2.17%. Among the 110 individuals with strabismus, 26 (0.51%) had esotropia, 74 (1.46%) had exotropia, and 10 (0.19%) had vertical strabismus. Results revealed no significant difference between genders regarding prevalence of strabismus (p>0.05). Strabismus group included 55 males (50.00%) and 55 females (50.00%). Prevalence rates of strabismus, exotropia and esotropia are presented in Table 1.

Myopia was the most common type of refractive error related to strabismus. Myopia, hyperopia and

Table 1: *The prevalence of strabismus by its subtypes and gender.*

	Total % (95% CI)	Male % (95% CI)	Female % (95% CI)
Strabismus	2.17 (1.55 to 2.66)	2.00 (1.28 to 2.77)	2.38 (2.41 to 3.11)
Exotropia	1.46% (0.98 to 1.89)	1.31 (0.96 to 1.65)	1.64 (1.03 to 2.31)
Esotropia	0.51% (0.20 to 0.84)	0.51% (0.21 to 0.79)	0.56 (0.22 to 0.75)

CI, confidence interval.

emmetropia were detected in 39.1%, 25.5%, and 35.5% of the deviated eyes. In addition, the prevalence of amblyopia was 2.55%. The results showed a considerably higher prevalence of amblyopia instrabismic participants (p=0.013). Accordingly, five strabismic (4.54%) and 124 non-strabismic (2.50%) participants had amblyopia. Moreover, 141 patients

(2.79%) had anisometropia. Prevalence of anisometropia was higher in strabismic patients (20.9%) than in non-strabismic ones. Furthermore, the participants were divided into seven groups based on age. Prevalence of strabismus, exotropia and esotropia demonstrated no significant correlations with age (All p>0.05, Figure 2).
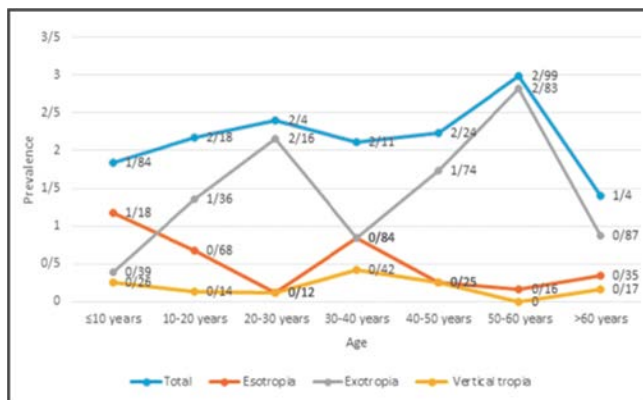

Figure 2: Prevalence of strabismus in different age groups.

Besides, six out of the 110 participants with strabismus (5.45%) had a positive family history.

DISCUSSION

This study aimed to investigate prevalence of strabismus and its correlation with some related factors in Mashhad, Iran. Prevalence of strabismus was 2.17%, similar to the results of some other studies.[20] Prevalence of strabismus is found to vary in different populations. A higher prevalence of strabismus has been reported in western and white people compared to Asian countries such as China and India.[10] Some extensive studies have also shown the effect of ethnicity on prevalence of strabismus.[10] This trend might be associated with differences in the esotropia/exotropia ratio. Prevalence of strabismus in different parts of the world are shown in Table 2.[11-20] Some studies have indicated a higher prevalence of exotropia in Asian countries and a higher prevalence of esotropia in western countries.[15-21]

Exotropia was the most common strabismus subtype in the present study. Ethnic differences may result from such factors as orbital shape, refractive errors and muscle insertion.[4] Distribution of strabismus subtypes can be affected by the type of refractive errors, esotropia and exotropia being more correlated to hyperopia and myopia, respectively.

Table 2: *The prevalence rates of strabismus in different parts of the world.*

Country/Area	Age range	Strabismus	Exotropia	Esotropia
China[10]	6-72 months	0.80%	0.67%	0.10%
Iran (Shiraz)[11]	6-21 years	3.1%	2.1%	0.9%
USA[5]				
Asia	6-72 months	3.5%	2.1%	1.4%
Non-Hispanic Whites	6-72 months	3.2%	0.8%	2.3%
Japan[12]	6-12 years	1.0%	0.6%	0.2%
Sweden [4]	4-15 years	3.5%	0.7%	2.8%
USA[13]				
White Americans	6-71 months	3.3%	1.8%	1.5%
African Americans	6-71 months	2.1%	1.0%	1.0%
USA[14]				
Hispanics	6-72 months	2.4%	1.5%	0.9%
African Americans	6-72 months	2.5%	1.4%	1.1%
Japan[15]	6-11 years	1.28%	0.69%	0.28%
Australia[16]	6 years	2.8%	0.8%	1.4%
Iran (Shahroud)[17]	6 years	1.2%	-	-
Korea[18]	5-18 years	1.6%	1.3%	0.3%
Singapore[19]	6-72 months	0.8%	0.7%	0.1%
Iran (7 cities)[20]	7 years	1.7%	1.3%	0.4%
Iran (rural areas)[2]	≤ 1 year	4.3%	3.9%	0.4%

Sincesotropic individuals need more accommodation compared to exotropia to compensate for hyperopia, higher prevalence of esotropia compared to exotropia in western populations can be due to the higher prevalence of hyperopia in these countries.[22]

Furthermore, some studies have indicated that prevalence of myopia increased from 10.4% in 1993 to 34.2% in 2016 in the world. This trend might have led to an increase in the exotropia/esotropia ratio in the past decade.[21]Thus, the type and amount of refractive error could be the main etiologic factor for strabismus. On the other hand, Chew et al, disclosed that the prevalence of strabismus subtypes could be affected by independent factors such as maternal smoking during pregnancy and maternal age.[9]Some studies have reported a significant difference between males and females. Faghihi et al, mentioned that the higher prevalence of hyperopia in females was the reason for the higher prevalence of strabismus in this gender.[11] However, numerous studies have demonstrated no significant difference between the two genders in this respect.[2] The present study also revealed no considerable difference between the two genders regarding prevalence of strabismus. The inter-gender differences reported in some studies might result from the genetic, ethnic and morphologic differences in the study populations and environmental factors. Some studies have shown a negative correlation between prevalence of strabismus and age, while another research indicated a positive correlation between prevalence of strabismus and age.[14] However, the current study findings demonstrated no significant correlation between strabismus and age. Other studies performed on the subjects aged 1–6 years[13] and 3–93 years,[2] also showed no significant correlation between prevalence of strabismus and age. The discrepancy among the results might be attributed to genetic and environmental differences.[5]

Strabismus is one of the most common causes of amblyopia. Therefore, programs have been considered for early childhood screening. Nonetheless, absence of screening programs has resulted in higher prevalence of amblyopia in some other countries. Different prevalence rates of anisometropia among studies could be due to varying methods of investigation, definitions and population characteristics. The prevalence of anisometropia was 2.79% in Mashhad. In the current research, the prevalence of the family history of strabismus was 5.45%. Even though the inheritance pattern has not been characterized accurately, most studies have agreed on multifactorial inheritance.[23]

Although in our study, no correlation was found between age and prevalence of strabismus, it is common for strabismus to be mistaken for a childhood disorder. It is possible for strabismus to develop in childhood and remain untreated until puberty. Strabismus in children has different causes than adults. In adults, there can be myogenic disorders, increased blindness rates and Cranial nerve palsy.[24] Additionally, socioeconomic status may affect the ability of patients to receive strabismus therapy. In our study, 1.83

percent of children under 10 had strabismus. Patients with 50 to 60 years of age were most likely to have strabismus, and patients over 60 years had the fewest referrals and the lowest rates of strabismus. This may be due to age-related issues and reduced mobility, making it difficult for them to come for examination.

Lack of information about history of treatment, including strabismus surgery or orthopthic training, was a major limitation of our study. We could not find record of number patients who underwent strabismic surgery. Strabismus surgery rates might be different in different races/ethnicities. This different rate of strabismus surgery might have cultural and economic reasons as well.

It also was reported that the most common strabismus and strabismus surgery was for horizontal strabismus.[25] As no report has been found in the Mashhad race, so it is not possible to make an accurate prediction.

As it is evident that some cases of strabismus and amblyopia had been treated, the prevalence of these conditions could have been underestimated. Participants in this study were enrolled based on the magnitude of tropia detected on the unilateral cover test and Hirschberg test. Therefore, individuals with microtropia might have been missed and the total prevalence of strabismus might have been underestimated.

CONCLUSION

The study findings indicated that prevalence of strabismus was 2.17% in the population of Mashhad. The most common subtype of strabismus was exotropia. Additionally, myopia was the leading refractive error associated with deviated eyes among strabismic individuals. Finally, tropia showed no significant association with age.

ACKNOWLEDGMENTS

REFERENCES

1. **Williams GP, Pathak-Ray V, Austin MW.** The social impact of visual impairment. Br J Ophthalmol. 2007;**91(7):**986. PMID: 17576722; PMCID: PMC1955656.

2. **Hashemi H, Nabovati P, Yekta A, Ostadimoghaddam H, Behnia B, Khabazkhoob M.** The Prevalence of Strabismus, Heterophorias, and Their Associated Factors in Underserved Rural Areas of Iran. Strabismus. 2017;**25(2):**60-66. Doi: 10.1080/09273972.2017.1317820.

3. **Rajavi Z, Sabbaghi H, Baghini AS, Yaseri M, Moein H, Akbarian S, et al.** Prevalence of Amblyopia and Refractive Errors Among Primary School Children. J Ophthalmic Vis Res. 2015;**10(4):**408-416. Doi: 10.4103/2008-322X.176909

4. **Aring E, Grönlund MA, Andersson S, Hård AL, Ygge J, Hellström A.** Strabismus and binocular functions in a sample of Swedish children aged 4-15 years. Strabismus. 2005;**13(2):**55-61. Doi: 10.1080/09273970590922664.

5. **McKean-Cowdin R, Cotter SA, Tarczy-Hornoch K, Wen G, Kim J, Borchert M, et al.** Multi-Ethnic Pediatric Eye Disease Study Group. Prevalence of amblyopia or strabismus in Asian and non-Hispanic white preschool children: multi-ethnic pediatric eye disease study. Ophthalmology. 2013;**120(10):**2117-2124. Doi: 10.1016/j.ophtha.2013.03.001.

6. **Leone JF, Cornell E, Morgan IG, Mitchell P, Kifley A, Wang JJ, et al.** Prevalence of heterophoria and associations with refractive error, heterotropia and ethnicity in Australian school children. Br J Ophthalmol. 2010;**94(5):**542-546. Doi: 10.1136/bjo.2009.163709.

7. **Rabin RL, Rabin AR, Zhang AD, Burney EN, Rhee DJ.** Co-management of cataract and glaucoma in the era of minimally invasive glaucoma surgery. Curr Opin Ophthalmol. 2018;**29(1):**88-95 Doi: 10.1097/ICU.0000000000000444.

8. **Cotter SA, Varma R, Tarczy-Hornoch K, McKean-Cowdin R, Lin J, Wen G, et al.** Joint Writing Committee for the Multi-Ethnic Pediatric Eye Disease Study and the Baltimore Pediatric Eye Disease Study Groups. Risk factors associated with childhood strabismus: the multi-ethnic pediatric eye disease and Baltimore pediatric eye disease studies. Ophthalmology. 2011;**118(11):**2251-2261. Doi: 10.1016/j.ophtha.2011.06.032.

9. **Chew E, Remaley NA, Tamboli A, Zhao J, Podgor MJ, Klebanoff M.** Risk factors for esotropia and exotropia. Arch Ophthalmol. 1994;**112(10):**1349-1355. Doi: 10.1001/archopht.1994.01090220099030.

10. **Chia A, Dirani M, Chan YH, Gazzard G, Au Eong KG, Selvaraj P, et al.** Prevalence of amblyopia and strabismus in young Singaporean Chinese children. Invest Ophthalmol Vis Sci. 2010;**51(7):**3411-3417. Doi: 10.1167/iovs.09-4461.

11. **Faghihi M, Ostadimoghaddam H, Yekta AA.** Amblyopia and strabismus in Iranian schoolchildren, Mashhad. Strabismus. 2011;**19(4):**147-152. Doi: 10.3109/09273972.2011.622341.

12. **Matsuo T, Matsuo C.** Comparison of prevalence rates of strabismus and amblyopia in Japanese elementary school children between the years 2003 and 2005. Acta Med Okayama. 2007;**61(6):**329-334. Doi: 10.18926/AMO/32877.

13. **Friedman DS, Repka MX, Katz J, Giordano L, Ibironke J, Hawse P, et al.** Prevalence of amblyopia and strabismus in white and African American children aged 6 through 71 months the Baltimore Pediatric Eye Disease Study. Ophthalmology. 2009;**116(11):**2128-34.e1-2. Doi: 10.1016/j.ophtha.2009.04.034.

14. Multi-ethnic Pediatric Eye Disease Study Group. Prevalence of amblyopia and strabismus in African American and Hispanic children ages 6 to 72 months the multi-ethnic pediatric eye disease study. Ophthalmology. 2008;**115(7):**1229-1236.e1. Doi: 10.1016/j.ophtha.2007.08.001.

15. **Matsuo T, Matsuo C.** The prevalence of strabismus and amblyopia in Japanese elementary school children. Ophthalmic Epidemiol. 2005;**12(1):**31-36. Doi: 10.1080/09286580490907805.

16. **Robaei D, Rose KA, Kifley A, Cosstick M, Ip JM, Mitchell P.** Factors associated with childhood strabismus: findings from a population-based study. Ophthalmology. 2006;**113(7):**1146-1153. Doi: 10.1016/j.ophtha.2006.02.019.

17. **Jamali P, Fotouhi A, Hashemi H, Younesian M, Jafari A.** Refractive errors and amblyopia in children entering school: Shahrood, Iran. Optom Vis Sci. 2009;**86(4):**364-369. Doi: 10.1097/OPX.0b013e3181993f42.

18. **Han KE, Baek SH, Kim SH, Lim KH.** Epidemiologic Survey Committee of the Korean Ophthalmological Society. Prevalence and risk factors of strabismus in children and adolescents in South Korea: Korea National Health and Nutrition Examination Survey, 2008-2011. PLoS One. 2018;**13(2):**e0191857. Doi: 10.1371/journal.pone.0191857.

19. **Chia A, Roy L, Seenyen L.** Comitant horizontal strabismus: an Asian perspective. Br J Ophthalmol. 2007;**91(10):**1337-1340. Doi: 10.1136/bjo.2007.116905.

20. **Williams C, Northstone K, Howard M, Harvey I, Harrad RA, Sparrow JM.** Prevalence and risk factors for common vision problems in children: data from the ALSPAC study. Br J Ophthalmol. 2008;**92(7):**959-64. Doi: 10.1136/bjo.2007.134700.

21. **Yu CB, Fan DS, Wong VW, Wong CY, Lam DS.** Changing patterns of strabismus: a decade of experience in Hong Kong. Br J Ophthalmol. 2002;**86(8):**854-856. Doi: 10.1136/bjo.86.8.854.

22. **Hashemi H, Yekta A, Jafarzadehpur E, Ostadimoghaddam H, Eshrati B, Mohazzab-Torabi S, et al.** The prevalence of strabismus in 7-year-old schoolchildren in Iran. Strabismus. 2015;**23(1):**1-7. Doi: 10.3109/09273972.2014.999795.

23. **Leuder G, Archer S, Hered R, Karr D, Kodsi S, Kraft S, et al.** Basic and Clinical Science Course, Section 6: Pediatric Ophthalmology and Strabismus. San Francisco, CA: American Academy of Ophthalmology; 2014.

24. **Coats DK, Stager DR Sr, Beauchamp GR, Stager DR Jr, Mazow ML, Paysse EA, et al.** Reasons for delay of surgical intervention in adult strabismus. Arch Ophthalmol. 2005;**123(4):**497-499. Doi: 10.1001/archopht.123.4.497.

25. **Repka MX, Yu F, Coleman A.** Strabismus among aged fee-for-service Medicare beneficiaries. J AAPOS. 2012;**16(6):**495-500. Doi: 10.1016/j.jaapos.2012.07.010.

Authors' Designation and Contribution

Akbar Derakhshan; Associate Professor: *Concepts, Design.*

Aliakbar Sabermoghaddam; Professor: *Literature Search, Data Acquisition.*

Milad Abdolahian; Optometrist: *Statistical Analysis, Manuscript Editing.*

Siamak Zarei Ghanavati; Assistant Professor: *Manuscript Preparation, Manuscript Editing.*

Mohammad Taghi Shakeri; Professor: *Data Acquisition, Data Analysis.*

Mehran Alirezaei; Assistant Professor: *Design, Manuscript Preparation.*

Athar Zareei; Researcher: *Concepts, Statistical Analysis.*

Shahram Bamdad; Associate Professor: *Data Acquisition.*