Alpha Emitter Concentration in Blood of Iraqi Museum Workers

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Abstract

The aim of this study is to evaluate the risk of alpha emitter's concentrations and measure it in human blood. The current study was done in the central laboratory and archaeologist employees of the Iraqi museum; likewise, the study also involved employees in State board of antiquities and heritage and Abd al-karim qasim museum that are located in Baghdad, Iraq. CR-39 Detector was used to measure alpha emitters track density. 60 participants Blood samples were collected in total (30 people in workers and 30 people in controls that were collected from general population). The maximum obtained values of alpha track density were (213.16±7.58 tracks/ mm^2) and minimum obtained values (32.61±3.70 tracks/ mm^2) in workers group with average of (81.36±3.78 No. of tracks/mm^2) and the maximum obtained values of alpha track density were (219.37±6.75 tracks/ mm^2) and minimum obtained values (3.02±0.37 tracks/ mm^2) in control group with average of (28.45± 2.10 tracks/mm^2). The result showed higher alpha emitter concentration in workers compared to the control group. Based on these results, high alpha concentrations to museum workers and archaeologists may have increased risk to DNA damage and cancer compared to non-occupational workers.

Key Words: CR-39, Alpha Emitters, Archaeologist, Radon Gas.

DOI Number: 10.14704/nq.2021.19.10.NQ21162 **NeuroQuantology 2021; 19(10):89-94**

Introduction

Alpha radiation has been found to be more damaging to biological systems than gamma radiation(J. Brenner *et al.*, 2001). Radon gas has been found in old heritage buildings in high concentrations exceeding 700 Bq/m^3 (Nastro *et al.*, 2018) (Mansor and Rashid, 2020). Similarly, radon gas concentration in air was measured in state board of antiques and heritage to be 702 Bq/m^3("Unpublished data we got it through private communication.," no date). Radon gas is one of the most important alpha emitter because it accounts for half of exposure to natural ionizing radiation (*WHO,* 2009). To evaluate the risk of such exposures, the alpha emitter concentration in blood were measured. Exposure to alpha radiation may cause DNA damage and cancer (Sinitsky, 2014) (Sinitsky and Druzhinin, 2014). The monitoring of alpha emitters tracks in blood give a better understanding of environmental contamination of alpha radiation. Many other studies also measured alpha emitters in blood of cancer patients and found higher alpha emitter concentrations than normal people (Hassan *et al.*, 2019) (Abdulwahid *et al.*, 2020) (Sultana, 2017). Also, radon and uranium concentration were measured in blood of female cancer patients and found very high concentrations(Ahmed and Mohammed, 2020) (Salih, Jafri and Aswood, 2016). To the best of our knowledge, there is limited number of studies that measure natural alpha concentrations in blood of relatively healthy participants.

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Relevant conflicts of interest/financial disclosures: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.
Received: 07 August 2021 **Accepted:** 15 September 2021

Natural radioactivity also was found to cause DNA damage and increase mutation frequency (Forster *et al.*, 2002). Also telomere length was found to be shorter in high natural radon level areas (Autsavapromporn *et al.*, 2018). Adoptive response is seen in areas of high radon concentrations (Thompson, 2011)(Mohammadi *et al.*, 2006). Radon daughter were found to give changes to brain proteins (Berislav M Berislav M Berislav M Berislav *et al.*, 1999). Study found that radon inhalation of radon gas may have antioxidant effect in mice (Kataoka, 2013). CR-39 is a type of SSNT detectors than is characterized of high sensitivity than other SSNTDs that is used to measure alpha emitters in blood (Al-Talbany, Jaafar and Al-Nafiey, 2013) (Hasan and Kadhim, 2015). The aim of the current study is to measure natural alpha emitter's concentrations in blood and their link to occupation.

Materials and Methods

This study was done in State board of antiquities and heritage, Iraqi Museum and Abd Al-karim qasim museum in Baghdad. This study recruited 60 participants divided into two groups: the first group were 30 participants collected from general populations. The second group were 30 participants from the sites. All participants answered a questionnaire including general personal information and also included: smoking habits, recent radiation exposure, years of work, current infections, if diagnosed or treated from cancer, family history or genetic diseases and chronic diseases. 3 ml of venous blood were drawn using disposable 3 ml syringe and needle and placed immediately into a 3 ml EDTA tubes. The blood was kept in cold container and transferred to refrigerator to preserve it. One drop of blood of volume 35×10^{-6} L was pitied into a CR-39 of a (1×1) cm size, then used another piece with same size to put it on top the blood and it formed a sandwich. The sandwich was kept in very small plastic container and each of them was given a number. Numbering for participant is done according to the blood donations. They were all kept for 30 days.

CR-39 was used for the detection of alpha particles in blood. It belongs to type of detectors known as Solid State Nuclear Track Detectors (or in short SSNTD). When alpha particles pass through this material, it will produce a continuous damage along the particle path; these tracks are called latent tracks, because they are very small to be seen(Bhagwat, 1993).

NaOH was used as the chemical etchant for the CR-39. A normality of 6.25 was used. 62.5g was added of NaOH to 250 ml of distilled water. The etching continued for 8 hours in a 60°C water bath.

Tracks were visualized using an optical microscope with a known field of view and digital eyepiece and the photos taken were counted manually by using ImageJ program. Then, the density of tracks using the following equation was measured (Al-Rakabi, 2015):

$$\text{The density of tracks } (\rho_x) = \frac{\text{Average number of track}}{\text{Area of field of view} \times \text{Time of exposure}} \quad (1)$$

Results and Discussion

After collecting the results, it was clear that the employees group has more alpha track density (81.36±3.78 tracks/mm^2) than the control group (28.45± 2.10 tracks/mm^2). Refer to Table 1 for information on participants and their track density for workers group and Table 2 for control group. Also, See "Fig.1" that shows alpha track density for each worker participant and "Fig. 2" shows track density for each control participant.

Table 1. Represent each participant number and their age, duration of employment and alpha track density in workers group

No. of participant	Track densities (No. of tracks/mm^2) Mean± SE	Age (years)	Duration of employment (years)
21	152.59±4.24	32	1
22	32.61±3.70	30	1
23	106.93±13.73	32	1
24	34.94±2.40	29	1
25	55.44±1.57	53	28
26	71.28±2.35	50	1
27	43.79±2.27	24	1
28	59.64±3.60	30	1
29	184.51±7.32	45	20
30	44.73±0.88	34	6
31	41.23±4.71	47	13
32	51.25±1.5	59	28
33	55.21±2.98	59	18
34	166.10±5.67	27	1
35	57.31±1.92	26	1
36	38.44±0.90	29	1
37	122.07±11.30	26	1
38	41.23±1.07	30	1
39	40.07±1.18	28	5
40	47.29±1.48	41	7
41	113.22±3.18	29	1
42	42.16±1.52	55	25
43	38.90±2.10	55	34
44	48.45±2.92	31	9
45	96.68±4.05	49	20
46	55.91±2.71	34	1
47	136.52±3.02	38	8
48	213.16±7.58	56	2
49	149.80±3.88	34	7
50	99.24±7.79	22	1
Average	**81.36±3.78**	**37.8**	**8.16**



Table 2. Represent each participant number and their age and alpha track density in control group.

No. of sample	Track densities (No. of tracks/mm²) Mean± SE	Age (years)
1	10.74±1.28	32
2	56.88±2.72	43
3	14.93±1.79	31
4	28.82±2.59	49
5	18.62±0.71	48
6	219.37±6.75	52
7	9.17±1.20	57
8	23.47±1.80	44
9	52.80±6.61	25
10	24.23±2.02	65
11	17.60±2.57	40
12	11.27±1.20	23
13	29.35±1.36	20
14	3.93±0.71	52
15	32.23±2.28	23
16	5.24±0.53	36
17	6.29±0.46	35
18	32.65±3.25	17
19	22.54±1.12	21
20	16.83±2.77	17
51	59.40±6.53	62
52	39.37±2.45	65
53	11.41±1.55	34
54	8.85±0.88	38
55	3.02±0.37	45
56	70.35±4.36	34
57	5.59±0.32	41
58	5.82±0.51	40
59	6.75±1.23	45
60	6.05±1.12	47
Average	**28.45± 2.10**	**39.36**

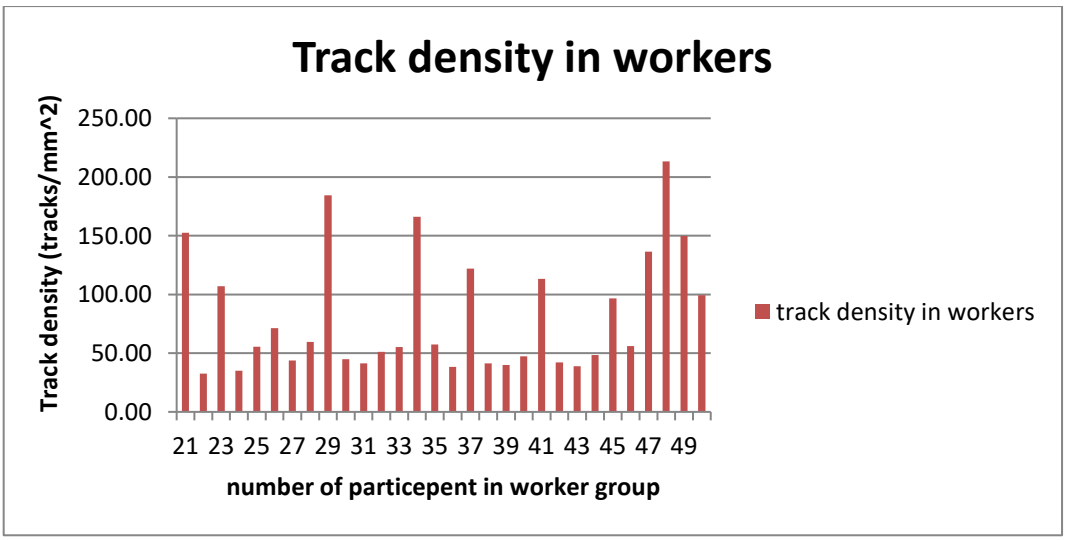


Figure 1. Track density in workers group

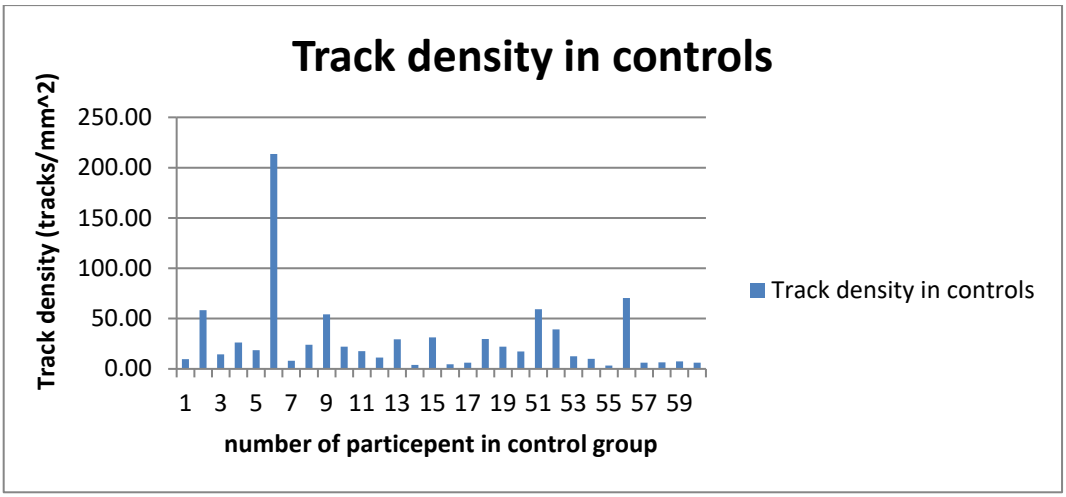


Figure 2. Track density in control group

Also, there is no association found between smoking and increased track density. See "Fig. 3" that display Track densities for current smokers in present study and "Fig. 4" that that display Track densities for never smoked participants in present study.

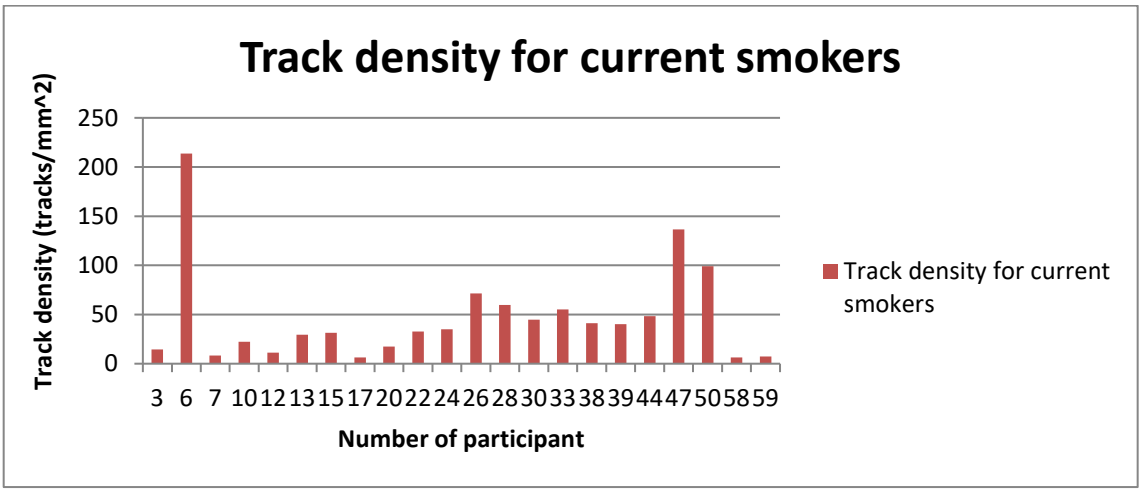


Figure 3. Track density for participants who are currently smoking

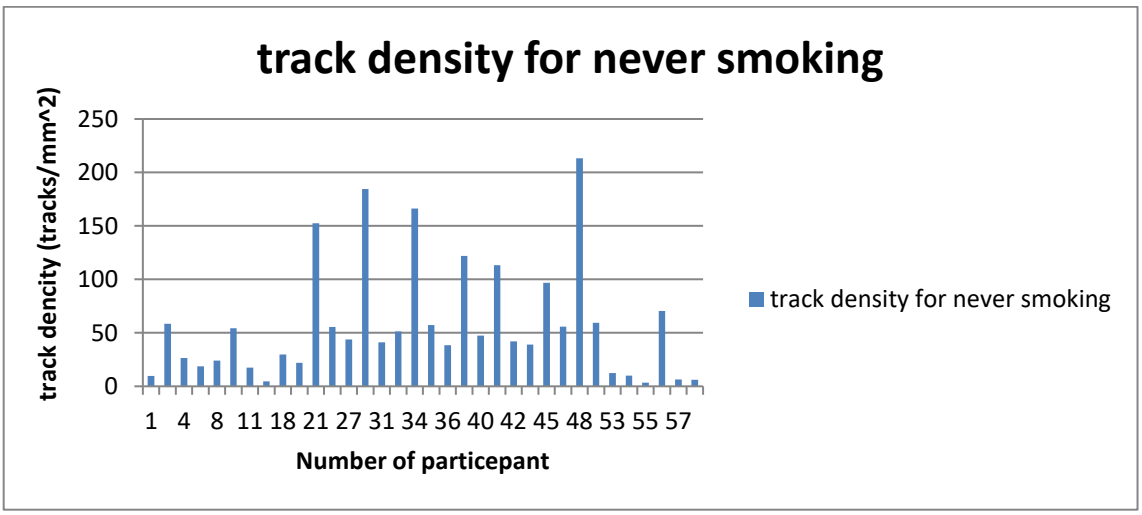


Figure 4. Track density for participants who never smoked

These findings point out that there is an association between occupation and increased alpha emitters concentration. These results can be contributed to lack of enforcement of safety laws and constant monitoring of air pollutant like radon gas in buildings. In addition, the type of occupation also may play major role in this increase (Waldron, 1985). Archaeologist and museum workers always handle and restore antiques that are made from natural materials from environment. These materials contain natural radioactivity. These antiques also is stored and displayed in the museum, which may lead to increase of concentrations of natural radiation in those buildings. They also usually work in old heritage buildings that may have increased radon concentrations(Baer and Banks, 1984). Other sources of contaminations maybe due to environment and food or water or wounds that are considered a pathway for contaminations of radionuclides(Al-Jameel, Ahmed and Shamran, 2019).

Conclusions

The outcome of this study demonstrated that alpha emitter's concentrations in blood of employees working in museums are more than other occupations. Those participants have no signs or symptoms due to current disease, not diagnosed or treated from cancer, have no genetic diseases that causes impaired DNA repair, and no recent radiation exposure. It is supposed due to the conclusion of this study, that high natural radioactivity and type of occupation may contribute to the increased DNA damage indicated in this current research. More research is needed.

Acknowledgments

We would like to thank all participants included in this study for their blood donations.

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