IOSR Journal of Dental and Medical Sciences (IOSR-JDMS)
e-ISSN: 2279-0853, p-ISSN: 2279-0861.Volume 14, Issue 8 Ver. VI (Aug. 2015), PP 101-104
www.iosrjournals.org

Effective dose received Radon 222 tap drinking water in the Age groups humans

Yadolah Fakhri[1], Maryam Mirzaei[2]
[1]*Social Determinants in Health Promotion Research Center, Hormozgan University of Medical Sciences, Bandar Abbas, Iran.*
[2]*Corresponding author;Research Center for non-communicable disease, Msc of critical care nursing, Jahrom University of MedicalSciences, Jahrom, Iran.*

Abstract: *Radon 222 is an odorless and colorless natural radioactive element which can endanger human health through the air inhalation and ingestion of contaminated food or water. The increase of the received effective dose of Radon 222 causes lung and stomach cancers in longtime. In the cross-sectional descriptive study, 24 samples of tap drinking water were collected from 8 regions of Jask City in June 2013. The concentration of Radon 222 was measured by Radon meter (model RTM1688-2). The effective dose of Radon 222 received by drinking water was calculated for various age groups by the equation of UNSCEAR. The range and the geometric mean of Radon 222 concentration was 105-304 Bq/m^3 and 198.8±61.9Bq/m^3, respectively. The mean of effective dose received by the age group of adult men, adult women, children and infants was 0.0020±0.006, 0.0015±0.005, 0.0002±0.0006 and 0.0003±0.0008 mSv/y, respectively. The order of effective dose in the different age groups is: Adult men> adult women> infants> children. Since the effective dose received by all age groups, particularly adult men, was less than standard limit (0.1mSv/y), so, there are no needs to remove the Radon222 from the tap drinking water in the water treatment plant Jask City.*

Key words:*Radon 222, tap drinking water, effective dose and age groups*

I. Introduction

Radon 222 is an odorless and colorless natural radioactive element which is a product of Uranium 238 chain. This element can be emitted from different sources such as surface water, groundwater, soil, igneous rock (granites) and sedimentary rocks [2 ,1]. Radon222 is ninety times more soluble in water than neon and helium [3].Humans are constantly exposed to radioactive materials, particularly Radon 222, through the inhalation of air and drinking water [4]. It is estimated that 89% and 11% of cancer risks are related to the inhalation of Radon 222 gas and drinking water containing Radon 222, respectively [5]. Because of the more contact of groundwater with igneous rocks (granites) and sedimentary beds, the concentration of radioactive material in groundwater can be more than in surface water [7 ,6]. Also, the concentration of Radon 222 in groundwater resources is 2 to 3 times more than the concentration of other radioactive materials [8]. When a person drinks the water containing Radon 222, this element enters the bloodstream by penetrating into the lining of the stomach and then spreads throughout the body [10 ,9 ,5]. The exposure of Radon 222 for a long time can cause blood, lung and stomach cancers [13-11]. The world Health Organization and European Committee has announced that the effective dose of Radon 222 resulting from drinks water must be 0.1 mSv/y [14]. This amount is separate from the doses of other radioactive materials of water (^{3}H, ^{226}Rn, ^{40}K) [15]. Many studies had measured the concentration and effective dose of Radon 222 in bottled water and tap drinking water [19-16 ,3]. In the study by me and my colleagues, the concentration of Radon 222 in the tap drinking water of Jask City was measured but its effective dose was not calculated [20]. So, in this study, it was tried to calculate the effective dose of it in the age groups of infants, children, adult men and women and also compare it with standard limit.

II. Materials and methods

1.2. Case study and sampling

The port town of Jask is located in N 25°39′11"N and 57°47′21"E, in the east-south of Hormozgan Province and at the 220 km of Bandar Abbas City (Capital of Hormozgan province) [21]. Its height is 2 meters above the sea level and its weather is hot and humid [22]. The drinking water of residents is provided from the surrounding wells. In the cross-sectional descriptive study, given to the similar studies in June 2013, 24 samples of water were gathered from the 8 regions of Jask City, including; Yekbeni, Loran, Sarrig, Maghsa, Kampan, Zolm abbad, Sarkaleh and Gharib abbad (3 samples from 2 different points in each region)[23].

2.2. Measurement concentration of Radon222

Regarding the effect of water temperature on Radon 222emissions, the temperature of all samples was reached to 12℃ [25 ,24]. The concentration of Radon 222 was measured by Radon meter (model RTM1688-2), manufactured in Sarad Company in Germany. The concentration of Radon222 water samples was measured in accordance with the instructions provided by the Sarad Company. The 2 hour mean concentration of Radon 222 samples was analyzed and recorded [26].

2.3. Calculate Annual effective dose received

To determine the annual received effective dose resulting from the drinking water containing Radon 222, the equation of The United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) was used [27].

Equation 1; $E=K\times G\times C\times T\times 1000$

Where E is the annual received effective dose (mSv/y); K is a factor to convert the concentration of Radon222 to the effective dose (Sv/Bq); G is the daily consumed water (l/d); C is the concentration Radon 222 (Bq/l); T is the time of water consumption (365 days) and 1000 is a factor to convert Sv to mSv. K is 18×10^{-9} Sv/Bq, 26×10^{-9} Sv/Bq and 35×10^{-9} Sv/Bq for adult men and women (17-65 years old), children (4-14 years old) and infants (less than 2 years old), respectively [29 ,28]. Many studies showed that the daily amount of water consumed by an individual is less than 2 liters which is different in various age groups. The daily amount of consumed water depends on the weather condition, physical activities, culture, economy and etc. Since there is no information on the exact amount of water used daily in different age groups of Jask City, EPA per capita water consumption in the regions with hot and humid weather (the statistical error of 5%) was used. Daily amount of water consumed by the age groups of adult men, adult women, children and infants is 2.723, 2.129, 0.431 and 0.327 l/p-d, respectively [30].

2.4. Statistical analysis

To compare the effective dose received by different age groups with the standard effective dose, T-test was used which was done by Spss16 software. Also, the P value<0.05 was selected as a significance level (α-5%).

III. Results

The range and the geometric mean concentration of Radon 222 was 105-304 Bq/m^3 and 198.8±61.9Bq/m^3, respectively. The mean of effective dose received by the age group of adult men, adult women, children and infants was 0.0020±0.006, 0.0015±0.005, 0.0002±0.0006 and 0.0003±0.0008 mSv/y, respectively (Table 1).

Table1. Effective dose received Radon 222 from the tap drinking water by different age groups Humans in the Jask City

Group age	Concentration of radon 222 (Bq/m^3)	G (m^3/d)	K (Sv/Bq)	E(mSv/y)
Mature (Male)	198.8 ±61.9	0.002787	1×10^{-8}	0.0020± 0.0006
Mature (Female)	198.8 ±61.9	0.002129	1×10^{-8}	0.0015± 0.0005
Children's	198.8 ±61.9	0.000431	2×10^{-8}	0.0006±0.0002
Infant	198.8 ±61.9	0.000327	3.5×10^{-8}	0.0008±0.0003

IV. Discussion

In this study, likes the study by me and my colleagues on this issue in Bandar Abbas City, the order of effective dose received by the different age groups is Adult men> adult women>infants>children [16]. Since the adult age groups consumed more water than children and infants (adult men: 2.723 l/d; adult women: 2.129 l/d), the annual effective dose received by this groups is more than one by children and infants. Since the P value, between the effective dose received by adult men and women, was obtained more than 0.05 (P value=0.33), it can be said that there are no significant differences between these two groups. Also, P value=0.18 shows that there are no significant differences between the mean of effective dose received by children and infants. P value=0.017, between the mean of effective dose received by children and adult men and P value=0.011, between the mean of effective dose received by children and adult women, show that there are significant differences between the effective dose received by children and adult men and women. Also, P value=0.026, between the mean of effective dose received by infants and adult men and P value=0.035, between the mean of effective dose received by infants and adult women, show that there are significant differences

between the effective dose received by infants and adult men and women. These significant differences between the age groups of infants and children and adult men and women are due to the less consumption of water. The effective dose received by the age groups of infants and children is more than by the age groups of adult men and women because their conversion factor is more.

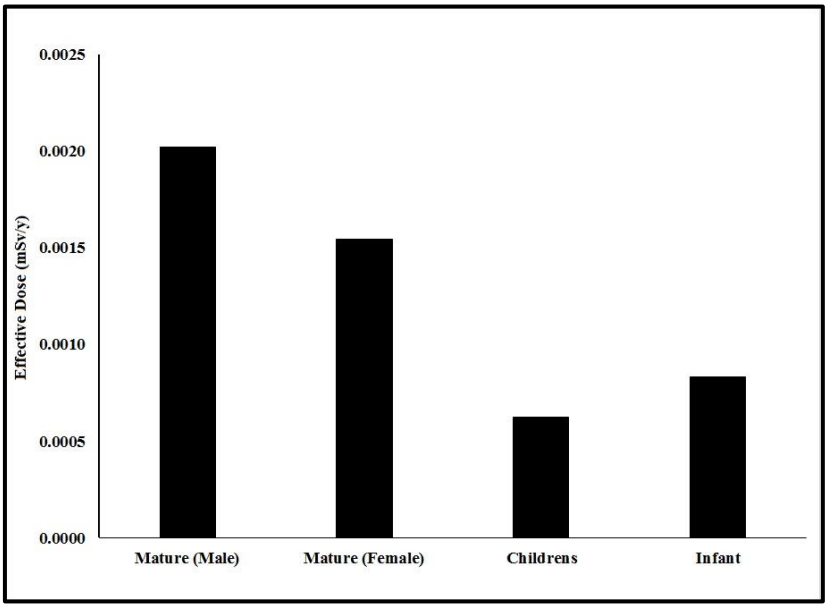

Figure1. Radon 222 effective dose received by different age groups humans in Jask City

The effective doses received by all age groups are less than standard of WHO (E=0.1 mSv/y). Even, at the maximum concentration of Radon 222 (304 Bq/m^3), it is much less than 0.1 mSv/y. In the study by me and my colleagues on the Radon 222 effective dose of bottled water received by different age groups, it was observed that in all age groups, the Radon 222 effective dose of bottled water is more than of Jask City's tap drinking water [16]. In the study, by Binesh et al. in the Mashhad City, the effective dose received by drinking water was more than one in our study (0.04 mSv/y) [31]. Because the concentration of Radon 222 in their study was more than one in our study. In the study by Somlai et al., the mean of effective dose received by the age groups of adult and children is 20.3 (1.13-88.7) and 40.6 (2.26-177 μSv/y), respectively. The received effective dose in their study is more than one in our study because the concentration of Radon 222 in their study was more than it in our study [15].

V. Conclusion

The effective dose received by all age groups, particularly adults, was less than standard limit (0.1 mSv/y). Therefore, there are no needs to remove Radon 222 from the tap drinking water of Jask City. However, with the change of the drinking water resource of Jask City from underground resource (well) to the surface resource (Jagin dam) in near future, it is expected that the concentration of Radon 222 and then the received effective dose will be more reduced.

Acknowledgement

The department of Environmental Health Engineering of Tehran University of Medical Sciences was the provider of radon 222 meter.

References

[1]. Oner, F., et al., The measurements of radon concentrations in drinking water and the Yeşilırmak River water in the area of Amasya in Turkey. Radiation protection dosimetry, 2009. 133(4): p. 223-226.
[2]. Kam, E. and A. Bozkurt, Environmental radioactivity measurements in Kastamonu region of northern Turkey. Applied Radiation and Isotopes, 2007. 65(4): p. 440-444.
[3]. Ahmad, N., M.S. Jaafar, and M.S. Alsaffar, Study of radon concentration and toxic elements in drinking and irrigated water and its implications in Sungai Petani, Kedah, Malaysia. Journal of Radiation Research and Applied Sciences, 2015.
[4]. M.Rožmaric, et al., Natural radionuclides in bottled drinking waters produced in Croatia and their contribution to radiation dose. Science of the Total Environment, 2012. 437: p. 53-60.
[5]. Oner, F., et al., The measurements of radon concentrations in drinking water and the Yeşilirmak River water in the area of Amasya in Turkey. Radiation protection dosimetry, 2009: p. ncp049.
[6]. Ali, N., et al., Estimation of mean annual effective dose through radon concentration in the water and indoor air of Islamabad and Murree. Radiation protection dosimetry, 2010. 141(2): p. 183-191.

[7]. Akawwi, E., Radon-222 Concentrations in the Groundwater along Eastern Jordan Rift. Journal of Applied Sciences, 2014. 14(4): p. 309-316.
[8]. Forte, M., et al., The measurement of radioactivity in Italian drinking waters. Microchemical Journal, 2006. 85 p. 98–102.
[9]. Organization, W.H., Guidelines for drinking-water quality: recommendations. Vol. 1. 2004: World Health Organization.
[10]. Motesaddi, S., et al., Effective dose of Radon222 and thoron220 in the indoor air of Genow hot springs of Bandar Abbas. Advances in Environmental Biology, 2014. 8: p. 453-459.
[11]. Colmenero Sujo, L., et al., Uranium-238 and thorium-232 series concentrations in soil, radon-222 indoor and drinking water concentrations and dose assessment in the city of Aldama, Chihuahua, Mexico. Journal of Environmental Radioactivity, 2004. 77(2): p. 205-219.
[12]. Smith, B.J., L. Zhang, and R.W. Field, Iowa radon leukaemia study: a hierarchical population risk model for spatially correlated exposure measured with error. Statistics in medicine, 2007. 26(25): p. 4619-4642.
[13]. Rožmarić, M., et al., Natural radionuclides in bottled drinking waters produced in Croatia and their contribution to radiation dose. Science of the Total Environment, 2012. 437: p. 53-60.
[14]. Somlai, K., et al., 222Rn concentrations ofwater in the Balaton Highland and in the southern part of Hungary, and the assessment of the resulting dose. Radiation Measurements, 2007: p. 491 – 495.
[15]. Somlaia, K., et al., 222Rn concentrations ofwater in the Balaton Highland and in the southern part of Hungary, and the assessment of the resulting dose. Radiation Measurements, 2006. 42: p. 491 – 495.
[16]. Fakhri, Y., et al., Effective Dose of Radon 222 Bottled Water in Different Age Groups Humans: Bandar Abbas City, Iran. Global Journal of Health Science, 2015. 8(2): p. p64.
[17]. Erdogan, M., K. Manisa, and F. Tel, The Measurment of radon activity concentrations in tap water in some dwellings of konya province-Turkey. Carpathian Journal of Earth and Environmental Sciences, 2015. 10(1): p. 273-278.
[18]. Fakhri, Y., et al., Determination concentration of Radon222 in Tap drinking water; Bandar Abbas City, Iran. IOSR Journal of Environmental Science, Toxicology and Food Technology
[19]. Li, T., N. Wang, and S. Li, PRELIMINARY INVESTIGATION OF RADON CONCENTRATION IN SURFACE WATER AND DRINKING WATER IN SHENZHEN CITY, SOUTH CHINA. Radiation protection dosimetry, 2015: p. ncv207.
[20]. Fakhri, Y. and M. Mirzaei, Determination concentration of Radon 222 in tap drinking water, Jask City, Iran. IOSR Journal of Environmental Science, Toxicology and Food Technology, 2015. 9(8): p. 6-9.
[21]. Llc, B., Hormozgan Province: Strait of Hormuz. 2010: General Books LLC.
[22]. Kitchin, R. and N.J. Thrift, International Encyclopedia of Human Geography. 2009: Elsevier.
[23]. Kralik, C., M. Friedrich, and F. Vojir, Natural radionuclides in bottled water in Austria. Journal of environmental radioactivity, 2003. 65(2): p. 233-241.
[24]. Ishikawa, T., et al., Airborne and waterborne radon concentrations in areas with use of groundwater supplies. Journal of radioanalytical and nuclear chemistry, 2005. 267(1): p. 85-88.
[25]. Somlai, K., et al., 222Rn concentrations of water in the Balaton Highland and in the southern part of Hungary, and the assessment of the resulting dose. Radiation Measurements, 2007. 42: p. 491-495.
[26]. GmbH, S. APPLICATION NOTE AN-003_EN: Measurement of the Radon concentration of water samples. June 2007; Available from: www.sarad.de.
[27]. Somlai, J., et al., Concentration of 226Ra in Hungarian bottled mineral water. Journal of Environmental Radioactivity 2002. 62: p. 235-240.
[28]. Somlai, K., et al., 222Rn concentrations ofwater in the Balaton Highland and in the southern part of Hungary, and the assessment of the resulting dose. Radiation Measurements 2007. 42 p. 491 – 495.
[29]. Binesh, A., et al., Evaluation of the radiation dose from radon ingestion and inhalation in drinking water. Int J Water Resour Environ Eng, 2010. 2(7): p. 174-178.
[30]. Agency, E.P., stimated Per Capita Water Ingestion and Body Weight in the United States–An Update. October, 2004. p. 40-45.
[31]. Binesh, A., A. Mowlavi, and S. Mohammadi, Estimation of the effective dose from radon ingestion and inhalation in drinking water sources of Mashhad, Iran. Iranian Journal of Radiation Research, 2012. 10(1): p. 37-41.