Atmospheric Pressure Change Measurement: An Observational Study

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Abstract

Introduction: The aim of the study was to show an atmospheric pressure change by indirect measurement in hermetically closed vessels during four years of follow-up.

Methods: Study design: an observational study. In hermetically sealed elastic bottles with different liquids were measured differences in liquid and air volumes from baseline to final follow-up period. The physical law of flotation was used to measure liquid and air volume above liquid in bottles. To measure liquid and air (above liquid) volumes in each bottle was used the physical law of buoyancy. The follow-up period was four years.

Results: The volumes of liquid and air in all bottles were decreased after the follow-up period to 14.38 ± 2.40 and 36.25 ± 3.37 ml, respectively. Air volume in comparison to liquid volume decreased more than two times significantly ($P=0.0007$) after the follow-up period.

Conclusions: Thus, atmospheric pressure increased during the last 4-year follow-up period. Further investigations are needed.

Introduction

Climate change observed in the worldwide in the last several decades. Global annually averaged surface air temperature has increased by 1.0°C over the last 115 years (1901–2016). (Wuebbles et al. 2017) Global warming since 1880 has followed a period of rapid acceleration in the past two decades. (National Centers for Environmental Information 2020) Database of NOAA's National Centers for Environmental Information evidences that hurricane activity in the world is increasing from 1851 to 2020. (NOAA's National Centers for Environmental Information & National Hurricane Center 2020) The 2018 U.S. National Climate Change Assessment reports that increase in greenhouse gases and decrease in air pollution have contributed to an increase in Atlantic hurricane activity since 1970.

Many other aspects of global climate are changing. For instance, changes in surface, atmospheric, and oceanic temperatures; melting glaciers; diminishing snow cover; shrinking sea ice; rising sea levels; ocean acidification; and increasing atmospheric water vapor. (Knutson et al. 2020) Nevertheless, a dynamic change in atmospheric pressure (AP) is presented incredibly rare. The aim of the observational study: to present a change in AP by indirect measurement of pressure in hermetically closed vessels for four years.

Materials And Methods

The observational study was conducted during four years (October 2016 – September 2020). Study objects: hermetically sealed eight elastic plastic bottles with different liquids: five bottles with non-carbonated drinking water from various manufacturers (#1-5 bottles); one bottle chemical solvent "646" (#6 bottle); one bottle with drying oil (#7 bottle); and one bottle with alkyd varnish (#8 bottle) (see Table 1).

To reduce a diffusion coefficient for air and liquids the tested plastic bottles were stored for the years in a dark (no light) and cooled (18-20 °C) place.

The tested plastic bottles were not opened, not moved during the observational period.

Changes in the shape of the bottles were evaluated at a temperature of 24 °C.

Review questions: 1) was there an association between changes in AP and pressure in the tested bottles; 2) was there a trend in increasing in AP?

Due to the permeability of liquids and air through PET bottles, (Keller & Kouzes 2017) we measured liquid and air volumes before (baseline) and after (final) follow-up period.

There were measured: 1) Baseline liquid volume; 2) Baseline Total volume (air+ liquid); 3) Final Liquid volume; 4) Final Total volume (air+ liquid); 5) Final Air volume; 6) Differences in liquid and air volume at the baseline and final.

To measure liquid and air (above liquid) volumes in each bottle was used the physical law of buoyancy, Archimedes' principle, stating that the volume of displaced fluid is equivalent to the volume of an object fully immersed in a fluid. (Randall et al. 2008)

Statistical analysis. Two-tailed Student's t-test with Bonferroni correction was used. The study data are presented in Table as Mean (M), Standard Deviation (SD), and Standard Error of the Mean (SEM), where SEM is SD divided by the square root of the sample size. P -value <0.01667 was considered significant as a Bonferroni-corrected P -value (98.33%); $n=8$; the number of tests were performed = 3. Statistical analysis was performed using Excel-2013.

Results

All eight observed bottles gradually deformed towards flattening during a not-opened four-year follow-up period (*An appendix*).

Table 1 shows the volumes of liquid and air in all bottles that were decreased after the follow-up period to 14.38 ± 2.40 ml and 36.25 ± 3.37 ml, respectively. Air volume in compared to liquid volume decreased more than two times significantly ($P=0.0007$) after the follow-up period.

Discussion

Decrease in liquid level in the hermetically sealed elastic-plastic bottle during four years can mean evaporation of liquid from the bottle's wall. Whereas the air volume decrease in the hermetically sealed bottle (inside the bottle) can mean a change in AP outside the bottle. Contemporary pet bottles have the best anti-permeability performance using active barrier (scavengers) to prevent the reaction with atmospheric substances. (Sangroniz et al. 2019)

Our study results showed indirect evidences of AP increasing during 4-year follow-up period based on the inverse relationship between changes in AP and pressure in the tested hermetically sealed bottles.

AP and temperature, both of them are physical factors, which directly proportional influence metabolic activity for every biological body on Earth. (Lopes et al. 2019); (Mota et al. 2020)

In the world, in the same place, AP is also changing in the last few decades. (Bielec-Bakowska 2016) Over the study period (1951-2015), a minor increase in the annual air pressure values (0.17-0.32 hPa/10 years) was identified.

Increasing metabolic rate, in turn, increases biochemical reactions in the body. Possibly, the accelerating development of humankind relates to this phenomenon. A metabolic rate change depends on AP. Weight gaining in the total population also could be a result of the raised metabolism. Further investigations are needed.

Conclusions

The study showed that atmospheric pressure increased during four-year follow-up period based on the simple indirect measurement of liquid and air volumes in hermetically sealed bottles. Further investigations are needed.

Abbreviations

AP
atmospheric pressure
MR
metabolic rate

Declarations

Data Availability Statement. Data are available as supporting information for review purposes.

Study limitations: The study has several limitations.

First, the study included indirect measurements to show the changing of AP.

Second, there had not the first picture of the bottles.

Third, there were intermediate follow-up time periods. Further investigation is needed.

Ethics approval and consent to participate. Not applicable

Consent for publication. Our manuscript does not contain any person's data in any form. All authors of the manuscript affirmed that they had access to the study data and reviewed and approved the final

manuscript.

Authors' contributions: *KO*: design and performance, literature analysis and review, bibliography review, data collection and interpretation, scientific analysis, scientific executor, writing, editing, and revision. *GB*: study design, re-writing the discussion, bibliography, and review. *KM*: study design, scientific analysis, research review, print. *AS*: study design, research executor, editing, and revision. *AT*: re-writing the discussion, bibliography, research review.

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Table

Table 1

Liquid and air volumes in the eight bottles at baseline and final of four-year follow-up period

# bottles	Liquid volume of the bottles, ml	Baseline Total volume (air+ liquid), ml	Final Total volume (air+ liquid), ml	Final Liquid volume, ml	Baseline Air volume, ml (3*-2*)	Final Air volume, ml (5*-4*)	Difference in Liquid volume at Baseline and Final, ml (5*-2*)	Difference in Air volume at Baseline and Final, ml (7*-6*)
1	2	3	4	5	6	7	8	9
1	600	680	625	590	80	35	10	45
2	500	555	505	480	55	25	20	30
3	500	550	500	485	50	15	15	35
4	500	550	495	480	50	15	20	35
5	500	560	515	480	60	35	20	25
6	500	555	510	480	55	30	20	25
7	1000	1090	1035	995	90	40	5	50
8	685**	1185	1135	680	500	455	5	45
						M=	14,38	36,25
						SD=	6,78	9,54
						SEM=	2,40	3,37
						t-test=		5,28
						Calculated P-value=		0,0007
Abbreviations: M, Mean; SD, Standard Deviation; SEM, Standard Error of the Mean. # 1-4, and 6 bottles are non-carbonated drinking water from various manufacturers; #5 bottle is chemical solvent "646"; #7 bottle is drying oil; and #8 bottle is alkyd varnish (the bottle was initially incomplete). * column # ; ** a bottle was initially incomplete.								

Supplementary Files

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- [Appendix.docx](#)