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The number of radiation beams audited during TLD postal dose audit performed by the Secondary Standards Dosimetry Laboratory in Poland in the context of the COVID-19 pandemic

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Laboratory accredited by the Polish Centre for Accreditation, accreditation No. AB 1499*

* an actual scope of accreditation No. AB 1499 is available on the PCA website: www.pca.gov.pl

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Introduction

Due to the COVID-19 pandemic, an epidemic state was in force in Poland from 20 March 2020 to 15 May 2022 in accordance with Polish legislation. From 16 May 2022 until further notice, a state of epidemic emergency is in force in Poland.

TLD postal dose audit is conducted to radiotherapy centres in Poland by the Secondary Standards Dosimetry Laboratory (SSDL) which is part of the Medical Physics Department of the Maria Sklodowska-Curie National Research Institute of Oncology in Warsaw. The Polish SSDL is a full member of the IAEA/WHO Network of SSDLs. The Polish SSDL has been accredited for the conformity with the norm ISO/IEC 17025 by the Polish Centre for Accreditation since 09 April 2014 and has the accreditation certificate No. AB 1499. In the scope of the aforementioned accreditation is determination of the dose absorbed in water ranging from 1.5 Gy to 2.5 Gy for X-ray beams in the range 4 MV - 25 MV and for electron beams in the energy range of 4 MeV – 22 MeV, **by thermoluminescent dosimetry method.**

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Introduction

The aim of this study was to check **whether the COVID-19 pandemic caused a decrease in the number of total radiation beams audited by the Secondary Standards Dosimetry Laboratory in Poland as part of the thermoluminescent dosimetry (TLD) postal dose audit**.

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Material

The material of this study was data on number of radiation beams audited by SSDL in Poland in 2020, i.e. the year the COVID-19 pandemic began, and those audited in five years before and in two years after 2020 (**i.e. in the period of 2015-2022**).

In the analyzed period, the SSDL in Poland operated as usual, carrying out orders of radiation therapy centers in Poland.

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Methods

Statistical techniques were applied to review the results, namely to analyze the association between the total number of beams audited in a given year counting **from 2015**, i.e. the first full calendar year of the SSDL's accreditation **till 2022** and number of years since 2020 when the COVID-19 pandemic was declared.

Moreover, an analysis of the number of X-ray beams and the number of electron beams audited in each year was performed.

The number of audited beams in a given year was also analyzed in relation to the number of centers that submitted to the audit.

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Methods

The **Pearson correlation coefficient (*r*)** is the most common way of measuring a linear correlation. It is a number between –1 and 1 that measures the strength and direction of the relationship between two variables.

The following table was used to assess the strength and direction of the relationship.

Note:
Although interpretations of the relationship strength (also known as effect size) vary between disciplines, the table below gives general rule of thumb.

Pearson correlation coefficient (r) value	Strength	Direction
Greater than 0.5	Strong (large)	Positive
Between 0.3 and 0.5	Moderate	Positive
Between 0 and 0.3	Weak	Positive
0	None	None
Between 0 and - 0.3	Weak	Negative
Between - 0.3 and - 0.5	Moderate	Negative
Less than - 0.5	Strong (large)	Negative

Positive correlation	When one variable changes, the other variable changes in the **same direction**.
No correlation	There is **no relationship** between the variables.
Negative correlation	When one variable changes, the other variable changes in the **opposite direction**.

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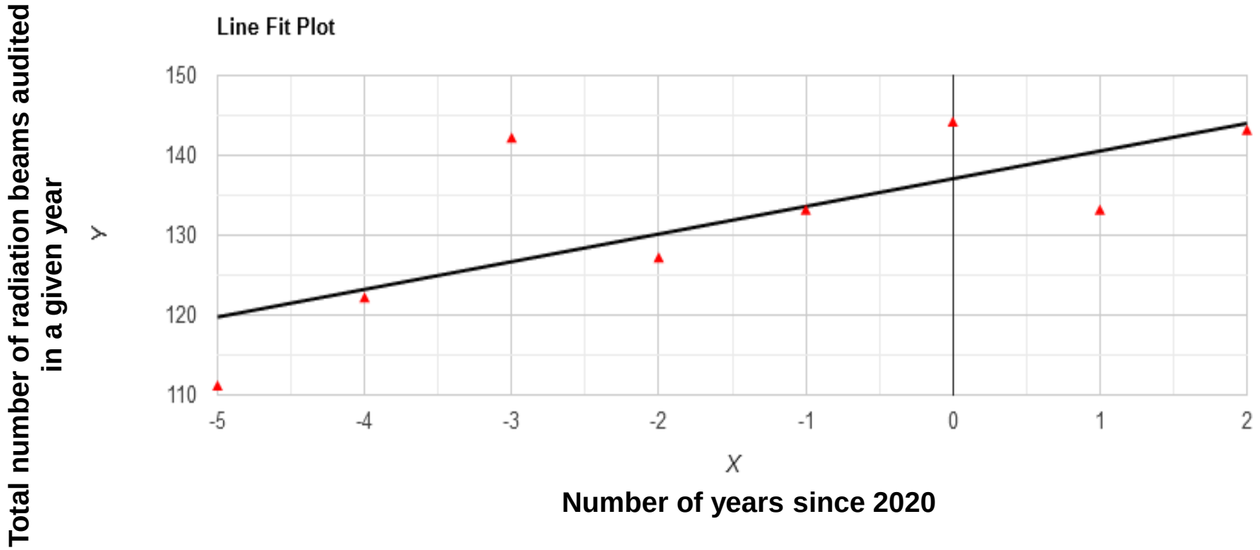
Results

Total number of radiation beams audited in years 2015 - 2022



Parameter	Value
Pearson correlation coefficient (r)	**0.7351**
P-value	0.03774
Covariance	20.7857
Sample size (n)	8
Statistic	2.6557

Outliers

Outliers' detection method: Tukey Fence, k = 1.5.
The data doesn't contain outliers.

Normality

The assumption was checked based on the Shapiro-Wilk Test (α = 0.05).
The Shapiro-Wilk tests for *X* values did not showed a significance departure from the normality, $W(8) = 0.974$, $p = 0.982$.
The Shapiro-Wilk tests for *Y* values did not showed a significance departure from the normality, $W(8) = 0.916$, $p = 0.437$.

Results of the Pearson correlation indicated that there was a significant large positive relationship between *X* variable (number of years since 2020) and *Y* variable (total number of radiation beams audited by the SSDL in Poland in a given year), (r(6) = 0.735, *p* = 0.038, significance level: α = 0.05).

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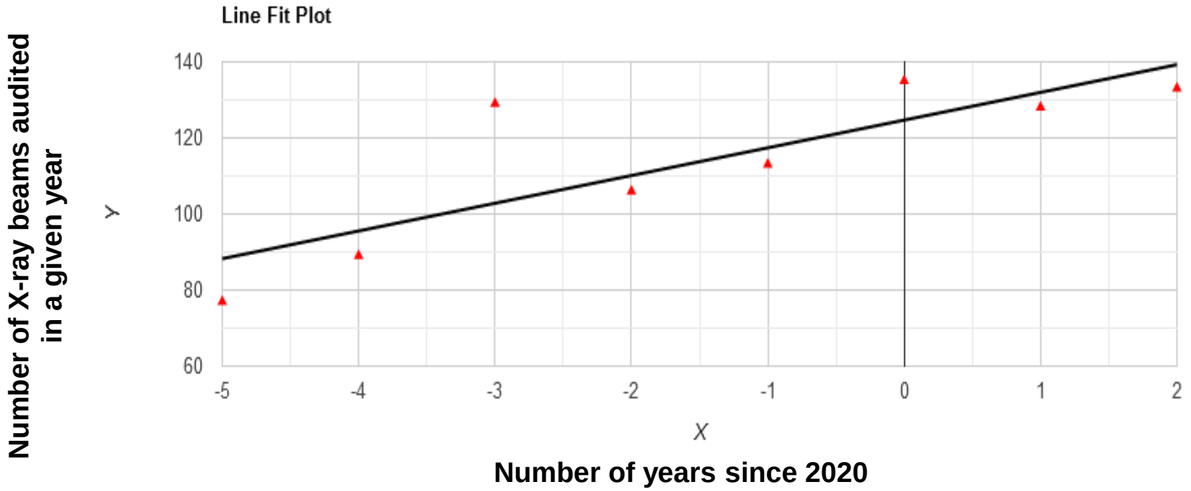
Results

The number of X-ray beams audited in years 2015 - 2022



Parameter	Value
Pearson correlation coefficient (r)	**0.8243**
P-value	0.01184
Covariance	43.7143
Sample size (n)	8
Statistic	3.5657

Outliers

Outliers' detection method: Tukey Fence, k = 1.5.

X doesn't contain outliers. Y doesn't contain outliers.

Pair outlier contains 1 potential outlier, which is 12.5% of the observations. ([-3,129]).

Normality

The assumption was checked based on the Shapiro-Wilk Test (α = 0.05).

The Shapiro-Wilk tests for *X* values did not showed a significance departure from the normality, $W(8) = 0.974$, $p = 0.982$.

The Shapiro-Wilk tests for *Y* values did not showed a significance departure from the normality, $W(8) = 0.884$, $p = 0.223$.

Results of the Pearson correlation indicated that there was a significant large positive relationship between *X* variable (number of years since 2020) and *Y* variable (number of X-ray beams audited by the SSDL in Poland in a given year), (r(6) = 0.824, *p* = 0.012), significance level: α = 0.05).

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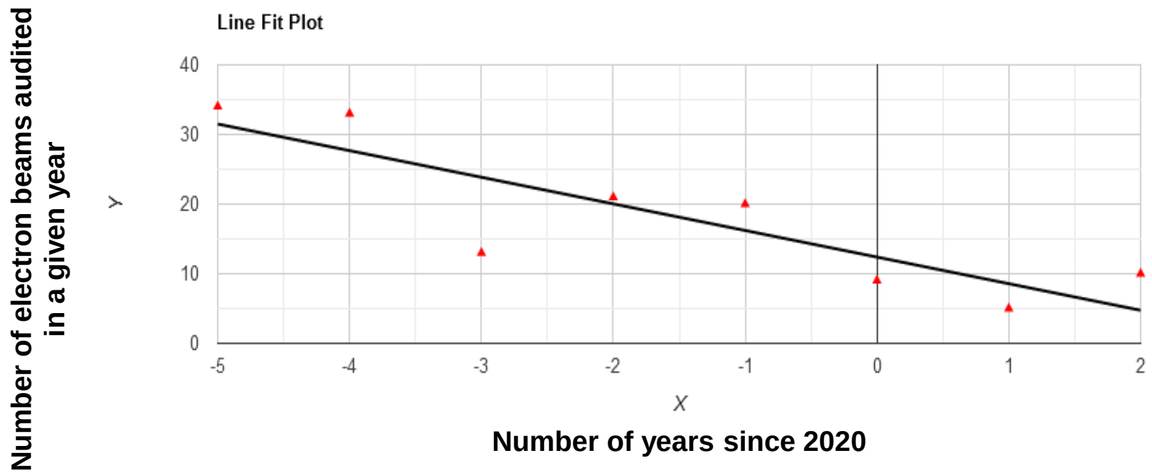
Results

The number of electron beams audited in years 2015 - 2022



Parameter	Value
Pearson correlation coefficient (r)	**-0.8581**
P-value	0.006399
Covariance	-22.9286
Sample size (n)	8
Statistic	-4.0942

Outliers

Outliers' detection method: Tukey Fence, k = 1.5.
The data doesn't contain outliers.

Normality

The assumption was checked based on the Shapiro-Wilk Test (α = 0.05).
The Shapiro-Wilk tests for *X* values did not showed a significance departure from the normality, $W(8) = 0.974$, $p = 0.982$.
The Shapiro-Wilk tests for *Y* values did not showed a significance departure from the normality, $W(8) = 0.905$, $p = 0.348$.

Results of the Pearson correlation indicated that there is a significant large negative relationship between *X* variable (number of years since 2020) and *Y* variable (number of electron beams audited by the SSDL in Poland in a given year), (r(6) = -0.858, *p* = 0.006, significance level: α = 0.05).

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Results

The number of audited beams in a given year in relation to the number of centers that submitted to the audit

Year	Number of audited beams	Number of centers that submitted to the audit
2015	111	33
2016	122	35
2017	142	37
2018	127	38
2019	133	39
2020	144	42
2021	133	42
2022	143	42

From 2015 to 2020, the number of centers that submitted to the audit has steadily increased. It has not changed from 2020 to 2022.

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Conclusions

There **is an increasing trend in the total number of radiation beams audited in the period of 2015-2022.** Obtained results **are in line with our expectations because the COVID-19 pandemic should have not caused a decrease in the total number of radiation beams audited by the Polish SSDL.**
In addition, there is an increasing trend in the number of X-ray beams, and a decreasing trend in the number of electron beams audited in the analyzed period.

These results may indicate **the high awareness of medical physicists responsible for dosimetry** in radiotherapy centers in Poland about the **need for undergoing a dosimetry audit,** despite the COVID-19 pandemic and related restrictions announced for the first time in the history of the SSDL and of radiation therapy centers in Poland.

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Thank you for your attention.