Gender Equality in Math-Themed Picture Books: The Example of "Math Matters"

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Abstract

The purpose of this study is to examine the extent to which math-themed illustrated children's books reflect gender equality. Document analysis, a qualitative research method, was used in the study. The research object consists of a 16-book series published by TUBITAK under the name "Math Matters," determined through criterion sampling. Descriptive analysis and chi-square test were used in the data analysis process. The books were analyzed based on categories created through a literature review ("frequencies of genders in title/main character/secondary character/general in text and picture", "parental roles", "occupational roles", "location of genders", "activities of genders"). MAXQDA 2022 data analysis software was used in the analysis process. The findings were summarized using graphs. Then, one-sample chi-square tests were conducted using the SPSS program to determine whether the differences in codes and categories were significant by gender. As a result, it was found that math-themed illustrated children's books, which were written to make math enjoyable and understandable, contain traditional gender stereotypes such as the underrepresentation of females, the emphasis on maternal roles, their limited portrayal in the home and its surroundings, their presentation in service-oriented and limited stereotypical professions, their activities being based on low cognitive skills and household chores, and their clothing emphasizing their sexual attractiveness and beauty, and being depicted in a home environment.

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INTRODUCTION

In Türkiye, the proportion of women working in more prestigious and high-paying professions related to mathematics is quite low. According to 2022 data from the Union of Chambers of Engineers and Architects of Türkiye, approximately 24% of its members are women, while 76% are men. When the number of students studying in higher education in 2020-2021 is analysed, it is seen that male students are overrepresented in fields such as Information and Communication Technologies, Engineering, Manufacturing and Construction (TÜİK, 2022).

There are many factors that prevent girls, who are as successful as boys in mathematics during their school years (Ayvaz, 2013; Ergün, 2003; Yücel & Koç, 2011), from pursuing a career in mathematical fields. These factors include families' expectations of girls (Chaffee & Plante, 2022), peer norms (Wollf, 2021), teachers' beliefs about gender and classroom practices (Nurlu Üstün & Aksoy, 2022), gender biased elements in mathematics textbooks (Moser & Hannover, 2014; Nurlu, 2021), media with all its components (Hall & Suurtamm, 2020), and children's picture books written specifically on mathematics (Ladd, 2011).

Picture books play a significant role in shaping their understanding and adoption of gender roles. Every subject in the natural and social environment can be addressed in picture story books. The events and people fictionalized by the author to explain the chosen subject to the child are the reflection of real life in books and the child takes a step in the process of socialization as well as personal development (Ural, 2013). Children learn from picture books what other girls and boys do, what they say and how they feel, distinguish between right and wrong, and fulfil societal expectations for their age group (Weitzman et al., 1972).

Works of children's literature contain certain stereotypes about the male and female gender that exist in society. Gender stereotypes can be perpetuated through both the written and illustrated elements of picture books (Poarch & Monk-Turner, 2001). For this reason, children may be exposed to works that contain gender stereotypes and discrimination, which could result in the development of prejudiced attitudes and biases (Sever & Aslan, 2012). In this respect, women and men should be given egalitarian roles in works instead of subjects that emphasize and glorify male dominance (Demirel, 2011: 54).

Many studies have investigated the reflection of traditional gender stereotypes in picture books in Türkiye. Generally, these research have revealed that there is an inappropriate presentation of gender equality in the representation of women and men, division of labour within the family, occupational life, appearance and clothing of the heroes, and the places where they are located (Bagceli Kahraman & Özdemir, 2019; Oğuz Rollas, 2017; Erden, 2019). Similar results were obtained in studies abroad (Hamilton, 2006; Gooden & Gooden, 2021). There have been a few studies on children's picture books that focus on a field such as mathematics, which is under the influence of gender stereotypes (Ladd, 2011). However, it is seen that studies focusing on a gendered field such as mathematics have not been conducted in Türkiye.

Further studies on this subject are of great importance to understand how gender roles and stereotypes affect children's learning of mathematics. Children's books are one of the tools that help children learn gender roles at an early age and therefore have a great responsibility in terms of gender equality. As a result, examining mathematics-themed picture books in terms of gender equality can not only increase children's interest in mathematics, but also help raise awareness of gender equality. Such studies can help children's books fulfil their responsibilities in terms of gender equality and contribute to the questioning of gender roles and stereotypes by reaching a wider audience. This study aims to examine the extent to which math-themed picture books reflect gender equality.

Related Studies

Many studies discussing gender differences in mathematics focus on innate differences in brain development. In particular, factors such as fetal exposure to male hormones, brain size, different development of brain lobes and gray-white matter ratios are emphasized (Chapman et al., 2006; Ankney, 1992; Benbow & Lubinski, 2006; Leonard et al., 2008). There is no definitive answer as to exactly why gender differences in mathematics arise. However, studies on this subject suggest that social and cultural factors may play an important role in addition to innate factors.

Duffy, Warren, and Walsh (2001) found that female mathematics teachers interacted more with male students, provided them with more academic feedback, and offered more critiques that stimulated their thinking, compared to female students. Similarly, Tiedemann (2000) concluded that teachers evaluated average-performing female students as having less logical thinking ability than male students with the same academic performance and attributed the math achievements of female students more to effort while attributing unexpected failure to lack of ability.

Children may adopt these negative attitudes from many sources, including their parents, during the socialization process. Räty et al. (2002) found that parents of boys perceived their children as more capable in mathematics than parents of girls. When it comes to mathematical success, parents of boys tend to attribute it to innate ability, whereas parents of girls emphasize the role of effort in achieving success.

In addition, one of the issues examined in terms of gender equality is children literature. Since picture books, introduced to children at a young age, are an important tool for them to learn cultural and social values (Körükçü et al., 2016), they are believed to play a significant role in early gender role socialization (Weitzman et al., 1972).

Books have the potential to influence children's attitudes and gender roles, and are often a source for transmitting gender stereotypes. Numerous scholars have investigated various aspects of gender equality in children's picture books. In a study conducted by Creany in 1995, it was discovered that in children's picture books published during the 1970s, male characters were more frequently represented than female characters, and both genders were frequently portrayed in conventional, stereotypical roles. In the same study, it was observed that although there were some improvements in books published between 1980 and 1995, the number of male main characters still outnumbered the number of female main characters. The results of Temellioğlu`s (2021) study on gender roles in Andersen Fairy Tales also support this study. In the study, it was concluded that male and female characters do not appear equally, and male characters are approximately three times more than female characters.

Daily activities in children's books are important for readers to recognize and understand real world experiences. These activities are common experiences that children experience many times in their lives and therefore readers can identify with the stories. Brugeilles and colleagues (2002) conducted a study on the characters depicted in children's picture books, focusing on their daily activities. They also investigated whether the gender and characteristics of the male and female characters were influenced by the authors of the books. The study found that all of the children's picture books analyzed had a male-dominated narrative, with the majority of the characters being adults.

The role of parents has a great influence on children's development and the shaping of their personality. A well-written parental character can help readers identify with the character and understand their experiences. Anderson and Hamilton (2005) concluded that fathers are generally underrepresented in the gender roles of parents in the 200 picture books they analysed and that they are presented as shadowy and ineffective male parents. In a similar study (Dewitt et al., 2013), 300 children's picture books were analysed for their depictions of mothers and fathers in terms of companion, disciplinary, caregiving, nurturer, and provider roles. It was found that the traditional

model of the man as the breadwinner and the woman as the caregiver of the children was consistently portrayed in children's picture books. Another study was conducted to determine how the father figure in children's picture books is reflected through written and visual indicators. According to the results of this study, the roles of father figures in children's picture books are generally parallel to the stereotypes of society, although they do not completely overlap (Bencik Kangal et al.,2017).

In children's books, the setting is a factor that affects the environment and atmosphere in which the story takes place and the behaviour of the characters. Based on this fact, Tognoli et al.(1994) examined how male and female characters are depicted in children's picture books indoors and outdoors, at home and at work. According to the results of the study, the pre-1980 data showed that adult male characters were more likely to be depicted outside the home, while female characters were more likely to be depicted indoors. However, in post-1980 examples, the number and variety of occupations of male characters increased compared to female characters.

Occupations in children's books can help children explore different career options and see the world from a different perspective. Occupations can also influence the personalities, abilities, and life experiences of the characters in the story. In Günay and Gürşişmek's (2005) study on the evaluation of linguistic and non-linguistic indicators used in the treatment of gender roles in children's books, it was found that social value judgments play an important role in determining the occupations of women and men. In another study, the relationship between occupations and gender was examined, and it was found that more male characters were included in occupational groups, while female characters were generally attributed to traditional professions such as teachers and housewives (Özen et al., 2022).

Clothing is a significant element in children's picture books that can provide insight into the characters' personalities, lifestyles, and the setting of the story. ınar (2015) examined the clothing styles of female characters in picture books and discovered that the characters were often depicted wearing clothing that reflected social stereotypes and traditional beliefs. Kaynak (2017) conducted a study to investigate how gender roles are communicated through both linguistic and non-linguistic cues in story and fairy tale books. It was found that while traditional gender roles are still present in the examined books, they are portrayed in a more egalitarian way that is somewhat distinct from traditional approaches and stereotypes.

Studies show that gender discrimination can have an impact on children's math skills. Therefore, in materials that children frequently use, such as children's picture books, it is important to include math problems and problem-solving in all characters without gender discrimination. According to the findings of Ladd's (2011) study on gender discrimination in mathematics-themed picture books for children, it was observed that female characters were much less common than male characters and math problems were usually solved by male characters.

METHOD

Study Design

The research utilised document analysis, which is a qualitative research method, to investigate whether math-themed picture books reflect gender equality. Document analysis is a systematic and detailed qualitative research method that involves analysing the content of written documents (Wach, & Ward 2013). Analysing any type of document through document analysis can assist the researcher in uncovering meaning, gaining understanding, and discovering insights into the research problem. (Merriam, 1988). In this study, children's books, which are text-based documents according to Geray's (2006) classification, primary documents according to Balcı's (2007) classification and institutional documents according to Corbetta's (2003) classification, were analysed.

Objects of the Study

The object of study was determined through the use of criterion sampling strategy, which is one of the purposive sampling methods. In criterion sampling, situations that meet certain criteria are included in the study (Patton, 2014, p.243). Within the scope of the study, some criteria were determined for the identification of the books. These criteria are (1) being a children's picture book, (2) appealing to the primary school age group, (3) containing a fictional text, (4) having literary qualities, (5) being written in Turkish or translated into Turkish, and (6) having a mathematics theme.

Accordingly, a series of 16 books translated into Turkish by TUBITAK under the title Math Matters was selected in accordance with these characteristics. The reason for the selection of TUBITAK children's books in the study is that the publication of the books and the continuation of the printing is decided by an advisory board based on their recommendations. Another reason is that the age range of the book is determined by this advisory board based on objective criteria.

Researcher Role

In qualitative research, the researcher is viewed as an integral part of the data collection process (Denzin & Lincoln, 2008). For this reason, it is important that the researcher sincerely expresses his/her assumptions, biases, and expectations regarding the study (Greenbank, 2003). After conducting studies on the extent to which mathematical gender stereotypes exist in primary school teachers and how they affect their students, and whether mathematics textbooks and children's picture books have a fair presentation in terms of gender equality, it was aimed to examine gender presentations in mathematics-themed children's picture books. It is known that mathematics as a scientific field is gendered and attributed a masculine characteristic (Koblitz, 2002). However, it is also known that children's picture books carry gender stereotypes and sexist elements, thus limiting children's developmental potential and especially hindering girls' professional dreams and goals (Emir et al. 2022; Nahara, 1998). For this reason, it is thought that mathematics-themed picture books may also be a factor that can reproduce gender inequalities.

Data Analysis

In this study, descriptive analysis and chi-square test were used in the data analysis process. According to Miles and Huberman (1994), descriptive analysis is generally used in cases such as processing data that do not require detailed examination of a qualitative data set, describing different qualities and defining general characteristics. In this study, the descriptive analysis process was carried out within the framework of the stages specified by Dawson (2009). Accordingly, a framework was created from the study questions, the conceptual framework of the study, and the dimensions obtained from the literature review, and the categories under which the data would be organized were determined. Then, the textualand visual items in the series were examined many times by the researchers and an analysis system was created in accordance with the categories (Çınar, 2015; Gooden & Gooden, 2001; Ladd, 2011; Şeren et a., 2022; Tognoli et al.,1994; Dewitt et al., 2013) defined as a result of the literature review. The categories used to analyse the books can be listed as "frequencies of genders in title/main character/secondary character/general in text and picture", "parental roles", "occupational roles", "location of genders", "activities of genders". In order to ensure consistency between the researchers in the analysis process, 6 books corresponding to approximately 30% of the data set were analysed simultaneously and together by two researchers based on the code and category system created. MAXQDA 2022 data analysis program was used in the analysis process. The findings were summarized with the help of graphs. Then, one-sample chi-square tests were conducted with the SPSS program to reveal whether the differences in codes and categories were significant according to gender. The analysing process on the basis of categories was carried out as follows:

Frequency

The frequency of appearance of characters as girls, boys, women, and men in titles, main/side characters, and overall textual and visual elements has been examined. The study excluded names that were unisex and had no corresponding picture. If a first name was followed by "Hanım" (an honorific for women, similar to Miss/Mrs) or "Bey" (an honorific for men, similar to Mr.), it was assumed that the character was an adult. Additionally, adults were identified by kinship terms like mother, aunt, father, or uncle. Conversely, characters with only a first name were considered to be children. When necessary, pictures were used to distinguish between children and adults, based on factors such as clothing (e.g., school uniform or suit) and physical characteristics (e.g., height, beard). The following examples illustrate this approach:

Title

Sample analysis: Grandma's Button Box. This title was coded as women because it includes the term "grandma" is a kinship term used to refer to an adult female relative.

Sample analysis: Where's That Bone? Since this title does not contain any gendered expressions, it was coded as undefinable.

Sample analysis: Slowpoke. The original title of this work was "Slowpoke," but it was translated into Turkish as "Yavaş Kaan" (Slow Kaan). Even though the original title did not contain any gendered expressions, the Turkish translation was used for coding. As "Kaan" is a male name however, since it was not possible to determine whether the character was an adult or a child from the title alone, the cover image was examined (See Figure 1 below). Based on the image on the cover page, the title was coded as male.
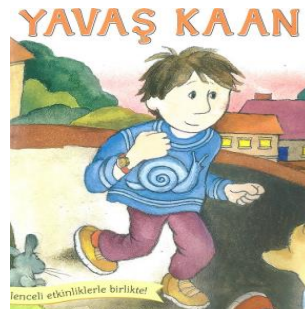

Figure 1. The Cover Page of Slowpoke

Main/Side characters

In the analysed books, the person who guides the narration, drives the story forward is coded as the main character. The person who has an indirect relation to the events is coded as the secondary character. Sample analysis: In a book that is based on a group of girls sharing the cleaning duties at camp, Ayşe, who narrates the events by writing letters to her parents, is coded as the "girl-main character". However, the camp counsellors, Jale and Nazlı, are coded as "woman-secondary characters".

Overall characters in textual and visual elements

Sample analysis: One day, they went to the zoo as a class. Since Kaan was the last one to get on the bus, he had to sit next to a teacher. And that teacher was Mr. Murat (Murat Bey). As "Murat" is a male name and the suffix "Bey" is added to the name, which is a Turkish honorific typically used for men, and also because a profession is assigned to the character, this case was coded as man.

Sample analysis: Pizza delivery person says having seen a rabbit. As the gender of the pizza delivery person cannot be determined from the text, the visual given below was investigated. Based on the image, the case was coded as a man.

Figure 2. The pizza delivery person

Parental roles

To identify parental roles, first, the frequency of the appearance of parents as mothers and fathers in visual and textual elements was determined.

Sample analysis: Dear Mom and Dad, Here's what happened after my letter… The words 'mother and father' were individually coded in the text.

Secondly, the parental roles in which the characters were engaged were classified as nurturing, caregiving, disciplinary, companion, and providing behaviours. Examples of these parental behaviours were classified as follows:

Nurturing behaviours have been defined as parental roles, including physical and verbal expressions of affection, verbal encouragement, emotional comfort, inquiries about thoughts, and praise for a completed task or activity, and listening to problems.

Sample analysis: The day after Kocapati arrived, Bingo did not eat his bone. Instead, he buried it somewhere in the backyard. Banu was looking out the window at that moment. She saw what he did.

"Why is he doing that?" she asked her mother.

"I think he's hiding his food from Kocapati," her mother said. This case was coded as a nurturing behaviour, as Banu's mother listened to her, answered her question, and provided an explanation.

Figure 3. Banu and her mother

The *caregiving* behaviours have been defined as parental roles, involving performing tasks related to the child's hygiene (such as bathing, cleaning, and changing diapers), attire (such as selecting clothes and dressing), and nutrition (such as preparing meals and feeding).

Sample analysis: I even knitted while my mother was removing the splinter stuck in my thumb. The case was coded as a caregiving behaviour, as the mother fulfilled her daughter's physical needs.

Figure 4. The girl and her mother

Disciplinary behaviours consist of parental roles that involve physical punishment, such as hitting to prevent harm to the child, or non-physical punishments such as sending the child to their room to reduce bad behaviour.

Sample analysis: My brother Melih chipped in, "Let me guess. Your mind was elsewhere, right? On another planet.' "Don't tease your sibling," scolded my mother. The case was coded as a disciplinary behaviour, since the mother was warning the child.

The *companion* behaviours involve three observed variables, which are taking the child on recreational trips, engaging in physical and non-physical play.

Sample analysis: Mr. Yiğit laughed and took Efe to the zoo at that hour on that day. Mr. Yiğit's behaviour of taking his son Efe to the zoo for the purpose of having fun was coded as a companion role.
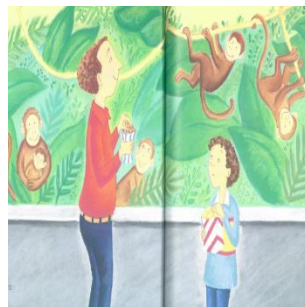

Figure 5. Mr. Yiğit and Efe at the Zoo

Finally, the *provider* role is fulfilled by any parent who works outside of the home.

Sample analysis: The next day, Efe left post-its all over the house with the message "Don't forget to increase Efe's pocket money." His father ignored them. The case was coded as providing behaviour as there is a request for an increase in pocket money.

Occupations

The textual and visual elements were directly analysed to determine the occupations of the characters regarding genders. Here are some examples of the analyses performed:

Sample analysis: Nowadays, customers flock to my grandmother's stand. They buy the necessary ingredients to make Bora's famous sauce. The case was coded as a woman vendor. The text

and picture indicate that the character is a vendor, and the term "grandma" is a kinship term commonly used to refer to an older female relative. Therefore, the case was classified as a female vendor.
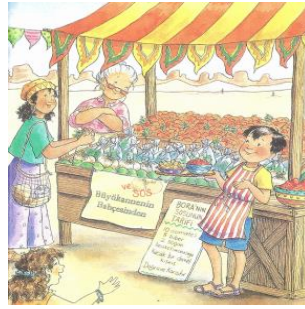

Figure 6. The grandma's stand in the marketplace

Locations

The characters' locations were analysed to determine whether they were presented indoors or outdoors, with respect to their gender. Below are some examples of the analysis:

Sample analysis: This case was classified as featuring a boy-indoors and a girl-indoors, because they are both in the kitchen looking for something in the refrigerator to feed their rabbit.

Figure 7. Mine and Mert in the kitchen

Sample analysis: My grandmother said, "That's it. A scarf like no other in this world. This scarf is for two people. Let's go for a walk. I want to get some fresh air with my scarf.". The case was classified as featuring a woman-outdoor and a girl-outdoors, as they were walking on the street.

Figure 8. The girl and her grandmother

Activities

The characters' activities were classified into different contexts, including leisure time, school related, mathematical, daily life, and work life activities. Below are some examples of the 'activities of genders' code:

Leisure time activities involve various activities such as engaging in social responsibility activities, having a picnic, or participating in cultural activities such as reading.

Sample analysis: As can be seen from the figure, the character is a girl who is sitting in an armchair and knitting. Therefore, the case was coded as "a girl in a leisure time activity."

Figure 9. The girl who is knitting

School related activities involve a range of tasks including listening to a lecture, working on a project, doing homework, or studying.

Sample analysis: As shown in the picture, there were a girl and a boy who were in a classroom and listening to a lecture. Therefore, the case was coded as "a girl in a school-related activity" and "a boy in a school-related activity".
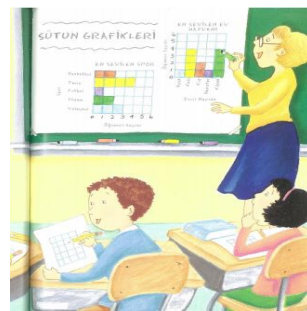

Figure 10. Students who are listening to a lecture

Activities related to mathematics include various tasks such as problem-solving, counting, graphing, and making inferences.

Sample analysis: In the image, a girl and a boy are seen engaged in making a table, thus the case is coded as "a girl in a mathematical activity" and "a boy in a mathematical activity".

Figure 11. Students who were making a table

Daily life activities refer to routine activities that individuals engage in on a regular basis as part of their daily life, such as eating, sleeping, working, shopping, exercising, and so on.

Sample analysis: Efe asked his classmates how much pocket money they received during lunchtime. He took notes. As it is seen in the picture, Efe and his classmates are having lunch, therefore the case was coded as "a girl in daily life activity" and "three boys in daily life activities".

Figure 12. Efe and his classmates

Work life activities include various occupational activities, such as teaching, working on a construction project, and harvesting.

Sample analysis: Bora called out to his grandmother from the window. "Grandma, is it time to go?"

"Not yet, we can't leave without gathering the things we will sell," his grandmother said. Based on the text and picture, Bora's grandmother is shown gathering vegetables to sell. Therefore, the case should be coded as "a woman in a working life activity."
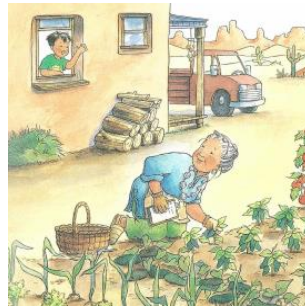

Figure 12. Bora's grandmother

Clothes

The visual elements were analysed to determine the clothing of the characters in terms of their types, colours, and accessories, based on their genders. Here are some examples of the analyses performed:

Sample analysis: As seen in the picture, Bora is wearing a green shirt and blue pants. In addition, he has glasses and a bag as accessories. There are multiple codes that need to be analysed here. The cases were coded as follows: "a boy with shirt", "a boy with pants", "a boy with green", "a boy with blue", "a boy with glasses" and "a boy with bag".
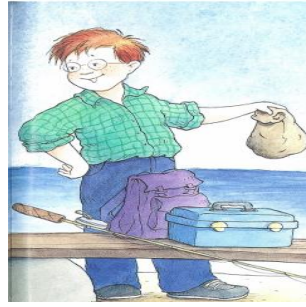
Figure 13. Bora fishing

Validity and Reliability

Lincoln and Guba (1985) state that the reliability of a qualitative research should include features such as credibility, transferability, dependability, and confirmability. In this study, these features will be tried to be provided as listed below:

1. Depth-oriented data collection technique was applied in order to ensure credibility. According to Yıldırım and Şimşek (2013), the researcher should reveal some patterns by constantly comparing, interpreting, and conceptualizing the results obtained. Thus, the researcher will go beyond functioning as a recorder. In this study, the findings were constantly compared with each other. It was found that the findings of each research question pointed to a similar pattern. For example, the study found that women were presented as mothers and portrayed as caregivers of children at a higher rate than men. Fathers, on the other hand, fulfil the duty of provider. In parallel with this finding, it was observed that women were more often presented indoors, while men were presented in public life. Similarly, father characters, who fulfil the function of provider, were portrayed more in professional roles. Therefore, all of these findings confirm each other and underline the judgment that women are presented as an entity that needs to be watched, protected and controlled.

2. Thick description and purposive sampling strategies were used to ensure transferability (Yıldırım & Şimşek, 2013). In the study, the details of the analysis process, such as the selection strategy of the data source, the presentation of analysis examples for each category, and the expression of researcher expectations and biases were revealed. In addition, the data set of the study was determined by purposive sampling method. As qualitative research whose aim is to reveal typical events and phenomena and their varying characteristics rather than obtaining generalizable information to the universe, the objects of study that meet certain criteria were selected as the data set.

3. A consistency review was conducted to ensure dependability. In this respect, it should be taken into consideration whether there is consistency in the activities carried out from the beginning to the end of the study (Yıldırım & Şimşek, 2013). Neuendorf (2002) mentioned the importance of ensuring consistency in coding when analysing the same text by two or more people. Within the scope of this study, to prevent the interpretation of codes and categories from differing from researcher to researcher, the analysis process of 6 books corresponding to approximately 30% of the series was carried out together and simultaneously.

4. Reflexibility was used to ensure confirmability. The perspective and position of the researcher shapes all study, including quantitative, qualitative, and even laboratory science. Malterud (2001) stated that the background and position of researchers influence the topic they choose to study, the methods they deem appropriate, and the framework of findings and conclusions. In this context, it was sincerely expressed that the researchers were oriented to the topic of this study with the results of their past studies and their expectations regarding the results of the study.

RESULTS

In this section, the study results were presented using descriptive statistics and graphs to depict the number of cases and determine whether gender equality was observed. Additionally, the chi-square test was used to analyze whether there were any significant differences between females and males.

Frequencies

Main/secondary characters/title

To determine whether genders were fairly represented in a series of math-themed children's books, an investigation was conducted into the representation of adult and child characters, including title characters, main characters, and secondary characters. A total of 1167 characters were coded, with 131 animals with no gender description excluded for comparison purposes. Of the remaining characters, 762 were children, comprising 210 girls and 552 boys, and 274 were adults, comprising 188 women and 86 men.

The analysis showed that children were represented more frequently than animals and adults in the series. However, it was found that girls were significantly underrepresented compared to boys (χ^2=0.00, df=1). Surprisingly, women were significantly overrepresented compared to men (χ^2=0.00, df=1).
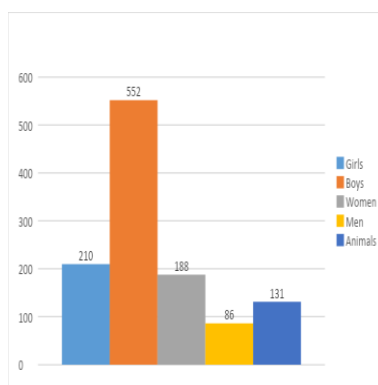

Figure 14. Gender representation of the characters

A total of 27 main characters were coded, consisting of 23 children (7 girls, 16 boys), 2 adults (2 women, 0 men), and 2 non-gendered animal main characters. For secondary characters, 86 codes were determined, with 41 children (22 girls, 19 boys), 42 adults (25 women, 17 men), and 3 non-gendered animals. Additionally, 8 titles were coded, including 5 children (1 girl, 4 boys), 1 adult (a woman), and 2 non-gendered animals.

Gender comparisons revealed that boys were portrayed more frequently than girls as main characters (χ^2=0.061, df=1) and mentioned more often in titles (χ^2=0.180, df=1). In contrast, girls were mostly portrayed as secondary characters (χ^2=0.639, df=1). Women were represented more frequently than men as both main and secondary characters (χ^2=0.217, df=1) and in titles. However, none of these comparisons were found to be statistically significant.
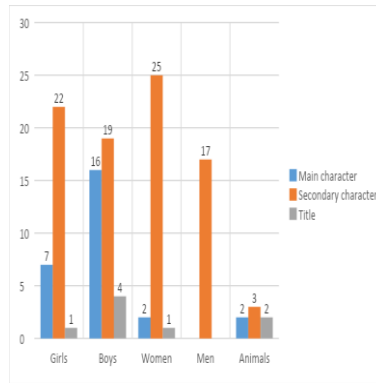
Figure 15. Gender representations of main/supporting/title characters

Parents

To assess whether parents are fairly represented in a series of math-themed children's books, the study examined the frequency and parental behaviours of both mothers and fathers. Out of the 91 parental characters identified in the series, mothers were found to be significantly more dominant, with a total of 57 characters, whereas fathers were represented by only 34 characters. The difference in frequency between mothers and fathers was statistically significant ($\chi^2=0.016$, df=1).
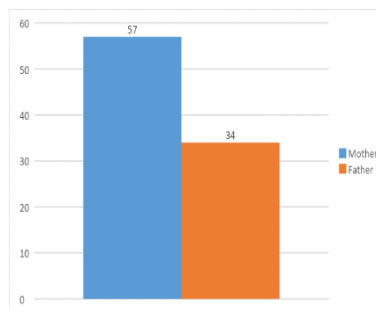

Figure 16. Frequencies of parents

Additionally, the study noted the parental behaviours exhibited by the mother and father characters in the series. The analysis revealed that the mothers tended to display significantly more nurturing ($\chi^2=0.006$, df=1), caring, and disciplinary behaviours compared to fathers. On the other hand, fathers were more likely to perform only companion and provider roles.
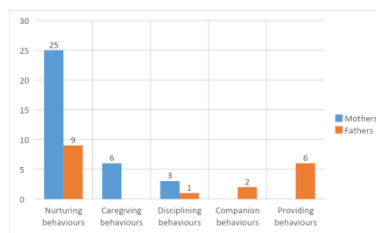

Figure 17. Frequencies of parental roles

Occupations

In the series of math-themed children's books, the frequencies and variations of the occupations were examined to determine whether the occupations are evenly distributed among the genders. Children were not portrayed in any professional roles. The number of professional roles was 21 for men and only 9 for women. Additionally, men tended to be portrayed in a variety of professional roles (18), and most of them were traditionally stereotyped such as school principal, dentist, business person, mail carrier, school bus driver, etc. On the other hand, women were depicted

in some limited traditional professional roles (4) such as teacher, shop assistant. The differences in the occupational presentations of the genders were found to be statistically significant both in terms of frequency (χ^2=0.028, df=1) and variety (χ^2=0.003, df=1).
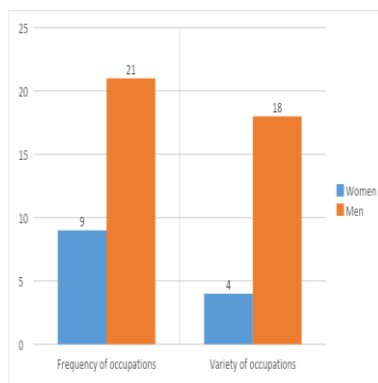

Figure 18. Frequencies and variations of occupations

Location

In the series of math-themed children's books, the frequencies of the locations male and female characters describe were examined in order to determine whether the genders systematically perform their activities indoors or outdoors. A total of 703 locations were coded and analysed for indoor/outdoor information. The presence of male characters was more common in outdoors compared to indoors (boys (χ^2=0.00, df=1); men (χ^2=0.06, df=1)), with the reverse being true for female characters (girls (χ^2=0.399, df=1); women (χ^2=0.569, df=1)). However, the outdoor/indoor difference was only statistically significant for boys. In addition, comparisons by gender were examined to explore whether there were any significant variations between the location of male and female characters. Women were significantly more likely to be depicted indoors compared to men (χ^2=0.005, df=1), while men were more commonly portrayed outdoors than women. However, this difference was not statistically significant (χ^2=0.646, df=1). Also, girls were significantly more frequently shown indoors than boys (χ^2=0.003, df=1), and boys were significantly more often depicted outdoors than girls (χ^2=0.00, df=1).
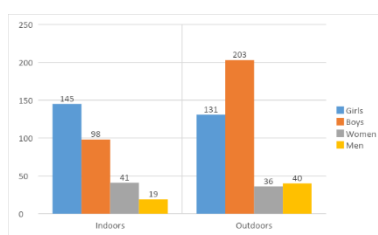

Figure 19. Location of genders

Activities

In the math-themed book series, it was examined whether the activities in which the genders were engaged were stereotypically presented. A total of 333 activities were coded for boys and girls. Mathematics (χ^2=0.00, df=1) and school-related (χ^2=0.035, df=1) activities showed statistically significant differences in frequency between the genders, while the others did not. For women and men, 84 activities were coded. None of the activities differed significantly between the genders.
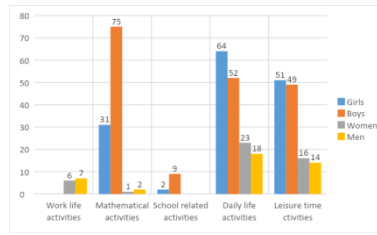
Figure 20. Activities of genders

In addition, the frequencies of the four most common leisure time activities such as art, playing games, sports and going out were compared between genders. Only a small number of comparisons yielded statistically significant differences. Girls portrayed in more playing activities than boys ($\chi^2=0.00$, df=1) when boys did more sports than girls ($\chi^2=0.02$, df=1).
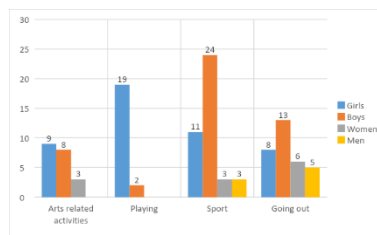

Figure 21. Leisure time activities of genders

Also, the four most common daily living activities, doing housework, cooking, taking care of children and gardening, were compared by gender. Except for doing the housework, none of these activities showed reliable differences in frequency between the genders. While this difference in doing the housework could be proved statistically significant for girls and boys ($\chi^2=0.001$, df=1), the difference between men (0) and women (10) could not be calculated as the men did not engage in any housework activities. However, the difference is clearly visible.
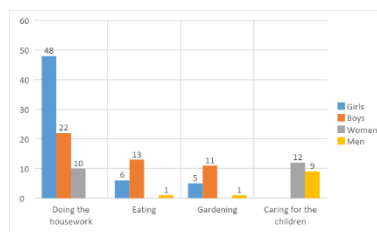

Figure 22. Daily living activities of genders

Clothing-type

In the math-themed book series, it was examined whether clothes, accessories and colours were chosen in a stereotyped way according to gender. A total of 310 clothes were coded for boys and girls. In the book series, girls were shown with more shorts ($\chi^2=0.00$, df=1), skirts, dresses, t-shirts ($\chi^2=0.001$, df=1) and athletes than boys, and boys with more pants ($\chi^2=0.010$, df=1) than girls. For women and men, 108 clothes were coded. It has been concluded that women wore clothes such as sweaters ($\chi^2=0.021$, df=1), t-shirts, athletes, coats, and kitchen aprons that are preferred in daily life and housework compared to men, whereas men were more often shown with business-specific clothes such as suits, shirts ($\chi^2=0.000$, df=1) and trousers than women.
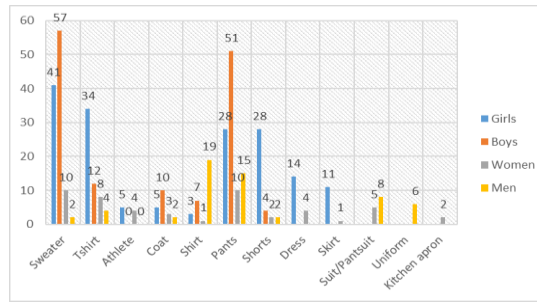
Figure 23. Clothes of genders

In addition, accessories worn by characters were compared by genders. Only one comparison revealed statistically significant differences. Women wore jewellery more often than men (χ^2=0.001, df=1). However, although there is no statistical significance, it is clearly seen that men wear glasses, hats, ties and belts that indicate business life and intelligence more than women, while women wear jewellery, scarves, hair clips that emphasise their sexual attractiveness and beauty more than men. A similar picture is also found in the comparison of accessories for boys and girls.
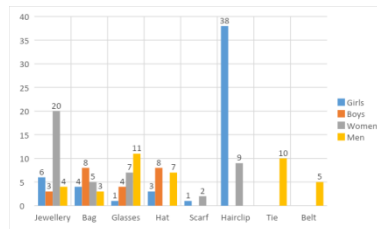

Figure 24. Accessories of genders

Also, colours chosen for the characters' clothes were compared by gender. It was observed that girls wore white (χ^2=0.02, df=1), purple (χ^2=0.001, df=1) and pink (χ^2=0.001, df=1) coloured clothes more than boys, and boys wore brown coloured clothes (χ^2=0.024, df=1) more than girls, and these differences were statistically significant. Also in the book series, grey is clearly shown as a boy colour. Adults comparisons revealed that purple (χ^2=0.003, df=1) and pink were presented as woman colours, and again brown was shown as a man colour (χ^2=0.001, df=1).
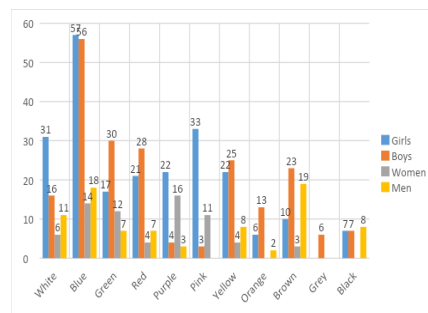
Figure 25. Clothing colour or genders

DISCUSSION AND CONCLUSION

Within the scope of the study, a series of 16 mathematics-themed children's picture books was analysed, and the series was evaluated in terms of whether it reflects gender equality. The frequency of gender representation in the series for children and adults was analysed separately, and it was concluded that boys were featured more than girls in both visual elements and texts, titles, and main characters. This finding is similar to the results obtained in the literature. Hamilton and colleagues (2006) found that the ratio of the number of boys to the number of girls per book was 1,2:1 and concluded that there was a significant difference. McCabe et al. (2011), on the other hand, found that

boys were given more space than girls in the titles and main characters of 5618 children's books they analysed. Weitzman et al. (1972) noted that a child who skims the titles of even the best-chosen children's books is likely to think that girls are unimportant because no one has bothered to write books about girls. Similarly, Casey and Lourenco (2021) stated that the underrepresentation of female characters in children's books contains an implicit message that they play a less important role in society. However, the findings of this study show that the same is not true for adults, and that female characters are generally more visible than male characters in titles, main and secondary characters. Although a complete numerical equality has not been achieved, studies conducted in the last few years show that a more egalitarian outlook has begun to prevail in children's picture books. In particular, there has been an increase in the number of female characters in titles, main roles and in illustrations and texts in general (Bağçeli-Kahraman & Özdemir, 2019; Bernstein, 2023; Gooden & Gooden, 2001; Paynter, 2011; Şeren et al., 2022).

Although it is a welcome development that female characters are more visible than male characters, it should be noted that the content is still sexist. For example, the findings of this study reveal that women's maternal role is significantly more emphasized than men's paternal role and that parenting behaviours are shaped based on traditional gender stereotypes. In the study, it was observed that mothers mostly assumed nurturing, caring and disciplinary parenting roles, while fathers fulfilled companion and providing roles. Similarly, researchers have stated that the father figure is given less space than the mother figure in children's picture books (Bencik Kangal, Karaaslan, & Arslan, 2017), women are mostly defined as mothers or wives, and they perform care-giving actions such as cooking for children, giving them hot chocolate, disciplinary actions such as yelling at them (Filipović, 2018; Weitzman et al., 1972) or nurturing actions such as meeting children's emotional needs (Dewitt et al., 2013). In other words, in children's picture books, mothers are portrayed as socio-emotional leaders of the household (Dewitt et al., 2013) and affectionate nurturers (Anderson & Hamilton, 2005). However, they underline that fathering behaviours are mostly limited to providing behaviours such as shopping for children and companion behaviours such as taking them on outings (Oğuz Rollas, 2017; Pang Abdullah, 2015; Dewitt et al., 2013).

The findings of the study revealed that in mathematics-themed children's picture books, women are presented in indoor spaces more than men and girls are presented in indoor spaces more than boys. When the literature is examined, it is seen that this finding is similar to the results of many studies. Researchers have revealed that males are presented in a wide variety of places such as parks and gardens, while females are presented in places limited to the house and home environment (Bağçeli Kahraman & Özdemir, 2019; Oğuz Rollas, 2022; Pang Abdullah, 2015; Şeren et al., 2022).

Similarly, Çınar (2015) analysed female figures in children's picture books and found that women are usually depicted in the home and deprived of the blessings of social life. Weitzman et al., (1972) stated that 40% of women and only 31% of men are depicted indoors in children's picture books. Hamilton et al., (2006) state that females are portrayed indoors more than outdoors, but the opposite is true for males.

The fact that women are frequently depicted in children's picture books in and around the home is also reflected in their representations in professional life. The findings of the study revealed that men are portrayed both more frequently and in more diverse occupational groups than women. In addition, it is seen that these professions are shaped based on traditional gender stereotypes and men are presented in more prestigious and high-paying positions than women. For example, in the series of mathematics-themed children's picture books analysed, it is seen that half of the professions given to women consist of the teaching profession. On the other hand, the school principal is portrayed as a man. This finding is also supported by the literature. For example, Bağçeli-Kahraman and Özdemir (2019) found that the number of female characters with any profession in children's books is even less than half of the number of male characters. Weitzman et al., (1972) also stated that in contrast to the limited range of women's professional roles, the roles played by men are diverse and interesting. Similarly, Emir et al., (2022) found that in children's books, men are presented in a wide variety of occupational groups such as tradesmen, drivers, doctors, police officers, and astronauts. On the other

hand, as Temellioğlu (2022) stated, service-based professions such as teaching, nursing, and nannying were deemed appropriate for women in children's picture books.

In the mathematics-themed picture books included in the study, boys were found to be more engaged in school and mathematics-related activities than girls. In parallel with the results of this study, Weitzman et al.,(1972) concluded that most of the professions requiring advanced education in children's picture books were occupied by boys, and therefore four of the boys and only one of the girls were presented in school life in the works they examined. Ladd (2011), in his study on mathematics-themed picture books for children, stated that only one female character is engaged in mathematical activities compared to seven male characters. When the characteristics of these mathematical activities were examined, it was found that the female characters performed actions requiring lower cognitive ability such as counting numbers or performing mathematical operations specified by the male characters, while the male characters were in the position of solving mathematical problems. However, when leisure time activities were analysed in the study, it was concluded that girls mostly played games while boys were engaged in sportive activities. It was observed that about half of the games of girls are carried out indoors and in small groups, shaped based on traditional gender stereotypes such as playing five stones or cards. On the other hand, boys were found to engage in a wide range of sporting activities such as fishing, boating, swimming, and running. In this respect, it is possible to state that the findings are in line with the literature. Researchers concluded that sports activities in children's picture books are mostly performed by male characters (Bağçeli Kahraman & Özdemir, 2019; Chick et al., 2010). Similarly, Yılmaz and Pala (2019), in their study examining the sports element in children's picture books, found that boys are the main characters of books about competitive sports such as football and basketball. In addition, in math-themed picture books, females are presented in housework activities significantly more than males. This finding, which is a manifestation of traditional gender stereotypes, is supported by many studies in the literature. Studies reveal that the main task of women is limited to housework, women are presented as the one who washes dishes and does laundry, cooks, sweeps the house and mops the floors, in short, cleans, tidies and shapes, and girls learn from their mothers to be good housewives (Çınar, 2015; Oğuz Rollas, 2017; Weitzman et al. 1972).

In the series of mathematics-themed children's picture books examined, it was observed that girls wore t-shirts, tank tops and shorts more often than boys, whereas boys were more frequently depicted in pants, sweaters, and shirts. Interestingly, the study findings revealed that girls are portrayed in a way that draws attention to their bodies. In parallel with this finding, Oğuz Rollas (2017) states that in story illustrations, the sexual attractiveness of females' bodies is revealed and presented to the reader. Beasley and Standley (2002) reveal that in computer games, another media item whose target audience is children, the female body is at the forefront and attention is drawn to the bodies of females, especially breasts, which carry strong sexual meaning. In parallel with this finding, the results of the study revealed that both women and girls are commonly represented in skirts and dresses in children's picture books. Weitzman et al. (1972) stated that the background behind the presentation of females in skirts and dresses in children's picture books is to pacify and immobilize them. After all, it is obvious that it is not possible to go from adventure to adventure in dresses with frills, sleeves, and ribbons. However, in children's picture books, the presentation of dresses and skirts is so integrated with females that it is possible to see females in these outfits regardless of the fiction of the story (Tsao, 2008). Researchers have found that artists depict female characters in dresses and skirts even when they are running, flying, working in the field, walking on a rope (Creany, 1995), riding a bicycle, playing ball or going to the zoo (Weitzman et al., 1972). For example, Filipović (2018) noted that in one of the books she analysed, a family on a bear hunt struggle with harsh natural conditions such as snowstorms on the road, and the men's clothing is appropriate for these conditions, but the females are still depicted in skirts and dresses.

In addition, when the clothes of women and men are compared, the study findings reveal that women are mostly depicted in clothes suitable for domestic life and work such as cleaning, while men are depicted in clothes suitable for business life such as shirts, suits, or uniforms. This finding regarding clothing also recalls the stereotype that women are integrated with the home. Vannicopoulou

(2004) indicated that in children's picture books, women are most commonly dressed in a kitchen apron, which both protects them from dirt and becomes a symbol of their place in the social stratum, unlike men who are depicted with briefcases. Temellioğlu (2022) stated that traditional gender stereotypes confine women to the home and see them as a weak being who needs to be kept under protection. For this reason, women are not adequately represented in business life and the role of men as breadwinners has remained unchanged from past to present (Dewitt et al., 2013). The study findings reveal that a similar situation is found in the accessories used by the characters in the series. Males are more often depicted with accessories that evoke business life such as glasses, hats, belts, and ties. On the other hand, females are depicted with accessories such as jewellery, hairpins and scarves that emphasize their beauty and sexual attraction. In addition, as Taylor (2003) stated, it is seen that females are depicted with certain coloured clothes and accessories to meet cultural beauty criteria in children's picture books. The findings of the study revealed that white, the symbol of purity and cleanliness, is predominantly used in the visuals, while pink and purple colours are used for the female characters. This finding is supported by many studies in the literature (Bağçeli Kahraman, Özdemir, 2019; Çınar, 2015; Şeren et al., 2022). Therefore, the beauty of females is at the forefront in illustrated children's books. As Temellioğlu (2022) stated, the stereotype that women find meaning with their beauty and beauty is what makes them important has found a place even in children's books.

As a result, it is seen that mathematics-themed picture books, which are written with the aim of making mathematics popular and understandable, contain traditional gender stereotypes, as females are underrepresented, their maternal roles are underlined, they are limited to the home and the home environment, they are presented in limited stereotypical occupational groups based on service, their activities are based on low cognitive skills and housework, their clothes are pictured in relation to the home environment, revealing their sexual attractiveness and beauty. It is thought that these books cause girls to move away from mathematics, which is already a gendered field (Koblitz, 2002). Weitzman et al. (1972) stated that girls who read children's books containing sexist elements have their ego and sense of self damaged and feel more inadequate and worthless. In this respect, it is known that children's books with sexist language and visual elements affect children's future lives by limiting their interests and even their skills (Chick et al., 2010; Taso, 2008). It is thought that a girl who reads the series examined in the study will decrease her sense of self regarding mathematics (Keller & Dauenheimer, 2003), which has a decisive role in access to higher levels of education and thus to more lucrative and prestigious professions (Keller & Dauenheimer, 2003), will feel inadequate to do mathematics, will lose interest in mathematics with the perception that mathematics is a man's job, and her professional preferences will be shaped in accordance with more traditional stereotypes.

Based on the results of the study, some suggestions can be made in the field of children's books. First, it is important that females, who make up about half of the society, are represented as much as males in main characters, titles and both visual and textual elements, especially in mathematics-themed picture books. In addition, attention should be paid to the use of text and visuals that show that mothers and fathers share domestic and family responsibilities equally, and to increase the number of father figures. Women's roles in public life should also be given more space. Women should be presented in alternative professional roles instead of traditional professional stereotypes. Women should be given more space in the presentation of professional, intellectual, and sporting activities. For example, messages containing gender stereotypes, such as male characters are more interested in or more successful in math or sports-related activities, should not be included in children's picture books. On the other hand, characters of different genders should be preferred in the presentation of housework activities. The occupations of the characters in the books should also push the boundaries of gender roles and emphasize that girls can also be successful in occupations related to mathematics. It is also expected that the clothing styles of the characters should be designed in accordance with the principle of child appropriateness. It is thought that mathematics-themed picture books designed in this way can increase awareness of gender equality and enable children to be freer and more flexible in their mathematics-related goals and dreams.

This study was not without limitations. It can be said that the limitations of the study are related to the process of determining the objects of study. This study is not a study that deals with all

children's picture books related to mathematics. The study is limited to 16 books of the series that were selected based on certain criteria such as appealing to the primary school age group, containing a fictional text, having literary qualities, being translated into Turkish or written in Turkish. In this respect, it is recommended that similar studies should be conducted with a group with a wider range of objects of study. In addition, there is no criterion such as being a best seller in the selection of the works examined, and therefore there is no information that the series examined in the study are the mathematics-themed children's books that reach children the most and affect them the most. For this reason, it is thought that it would be beneficial for the field to conduct studies examining the best-selling mathematics-themed picture books in terms of gender equality.

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CRediT Author Statement: Author 1 : Conceptualization, Visualization, Investigation, Writing- Reviewing and Editing. Author 2 : Methodology. Writing- Original draft preparation, Supervision .

Ethical Statement: Scientific, ethical and citation rules were followed during the writing process of this study; collected data no tampering has been done and this work does not belong to any other academic publication.

It was not sent to the environment for evaluation. The study was conducted in a manner that required ethics committee approval.

Since no data was collected, ethics committee approval was not obtained.

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