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Evaluation of the relationship between pediatric patients with mosaic down syndrome and hypothyroidism and treatment with honey: a cross-sectional study

Qutaiba Hommadi Mahmood Al-Samarraie[1,*]

[1] University of Samarra, College of Applied Sciences, Samarra, Iraq.

*Corresponding author: Qutaiba Hommadi Mahmood Al-Samarraie
University of Samarra. College of Applied Sciences, Samarra, Iraq.
E-mail: qutaiba.h@uosamarra.edu.iq
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Abstract

Introduction: Down syndrome is are three chromosome copies (trisomy) from chromosome 21 in the somatic cells of a person. People may have Mosaic Down syndrome, which is a combination of two types of cells, meaning that they are two cell lines of one fertilized cell (zygote). Some cells contain 46 chromosomes, indicating that they are normal cells, while other cells contain 47 chromosomes; cells with 47 chromosomes contain an extra chromosome 21. **Objective**: The relationship between Mosaic Down syndrome and thyroid gland shape and between Mosaic Down syndrome and thyroid gland hormones T3, T4 and TSH, and effect of honey on those with hypothyroidism. **Methods**: This cross-sectional study included 20 boys aged 10 years with mosaic Down syndrome and 6 controls. Karyotyping and thyroid hormone measurements were performed, and the effect of honey on thyroid hormone concentrations was evaluated. The study was approved by University of Baghdad Institutional Review Board, Baghdad, Iraq (reference No. 0854; 22 March 2025). Written informed consent was obtained from the parents or legal guardians of all participating children, and age-appropriate assent was obtained from the children before sample collection and study procedures. **Results**: The highest percentage of thyroid hormones (57, 0.75, 0.35), (T3, T4, TSH) in the sample in which the lowest percentage of mosaicism was 8.16%, and the lowest percentage of thyroid hormones was recorded (9, 0.01, undetectable), (T3, T4, TSH) in the sample that had the highest percentage of mosaicism (32.25%). The rate of decrease in thyroid hormone levels increases further as the percentage of mosaicism increases, the percentage of sister chromatids exchanged in the group with mosaic Down syndrome was (62.46 ±6.12) compared to the percentage of exchanges in the control group (41.61 ± 4.84), honey was highly effective in raising thyroid hormone levels. **Conclusion**: All patients with Mosaic Down syndrome have hypothyroidism, and the rate of decline in thyroid hormones increases further as the percentage of mosaicism increases, the higher the degree of mosaicism, the greater the rate of sister chromatid exchange, there were significant differences; honey raised the level of thyroid hormones in patients.

Keywords: Mosaic Down syndrome. Mosaicism. Hypothyroidism. Karyotyping. Thyroid gland. Sister chromatids exchanges (SCEs). Honey.

Introduction

Down syndrome is widespread syndrome worldwide in the and was described for the first time by an English doctor, John Langdon Down, in 1866, who described the symptoms of this disease, which are mental retardation, sexual immaturity, and lowered upper eyelid in a manner similar to the condition in the Mongoloid race, as well as the presence of deformities in the tongue, ear, and heart, and enlargement [1]. The large toe on the foot and the widening of the distance between it and the other adjacent toes, in addition to the deformity of the pelvic bone and a decrease in the number of ribs. In 1939, the Geneticist Cummins indicated that the difference in fine lines in the palms of the hands and the bottoms of the feet in humans is an indication of Down's disease [2].

This genetic disease is due to nondisjunction of chromosome 21, as there are three chromosome copies (trisomy) from chromosome 21 in the somatic cells of a person with Down syndrome [3]. A woman with this condition produces two types of ova, one of which contains two chromosomes 21. If this ovum is fertilized, it produces an individual with Down syndrome, or a spontaneous miscarriage of this fetus occurs [4]. Another type of ova contains one chromosome 21, which is normal and moderate in terms of the number of chromosomes, and if it is fertilized, it produces a normal individual (46,XX) [5] As shown in Figure 1.

People may have Mosaic Down syndrome, which is a combination of two types of cells, meaning that they are two cell lines of one fertilized cell (zygote). Some cells contain 46 chromosomes, indicating that they are normal cells, while other cells contain 47 chromosomes; cells with 47 chromosomes contain an extra chromosome 21 [6], and its prevalence is approximately 16% of all children with Down syndrome [7].

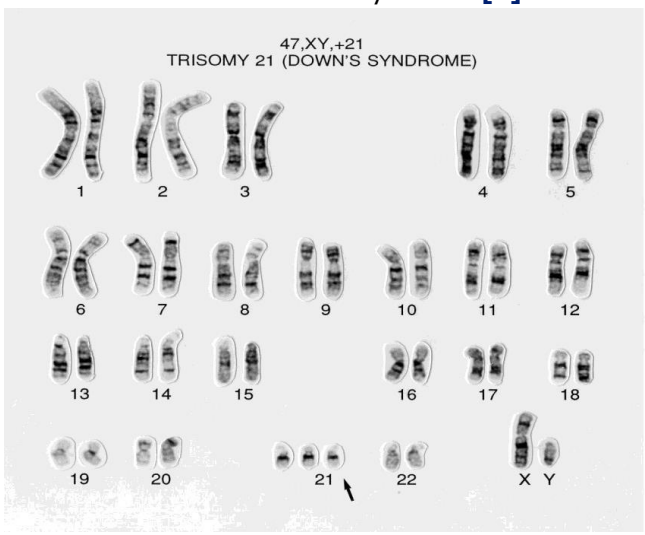

Figure 1. Karyotyping of Down Syndrome [5].

The thyroid gland is one of the largest glands in the body. It weighs 15-20 grams and is brown-red in color with a butterfly like shape. It consists of two lobes located in front of the larynx on either side of the trachea and is connected by the isthmus extending above the front surface of the trachea [8] The gland has the ability to store secretions in a greater quantity than any other gland. Despite its small size, it represents the basis for generating energy in the body. It can even be said that it controls the functions of the body as a whole [9].

Natural honey represents one of the most complex and interesting biological compounds in modern kinetic medicine and biotechnology. It is no longer viewed simply as a natural sweetener or highly concentrated carbohydrate, but rather as a multi-target therapeutic [10]. This exceptional importance lies in its unique chemical content that combines the secondary metabolites of the plant and the working enzyme secretions of bees, giving it a wide range of biological activities that synergize in an integrated manner to inhibit pathogens and stimulate living tissues [11].

Materials and Methods

Study Design

This study followed STROBE guidelines (Available on: https://www.strobe-statement.org/checklists/. Accessed on May 12, 2026) for cross-sectional studies.

Chromosome analysis (Karyotyping) was performed for 20 childhood males who were 10-years-old (The sample size at this number indicated a low incidence of this syndrome), all of whom had Mosaic Down Syndrome [12]. After that, thyroid function tests were performed using the ELISA technique, and the same tests were also performed for the control group, which consisted of 6 children and 10-year-old males. We recommended not taking drugs for 3 days before conducting tests on infected people (thyroid stimulants) [13], the sister chromatid exchange experiment was carried out according to the agreed scientific protocols [14], patients were fed honey to observe the effect of honey on the concentration of thyroid hormones in the blood. The normal values of the thyroid hormones in children as shown in Table 1.

Table 1. Normal thyroid hormone levels in children.

Hormones	Normal Values
T3	60 - 181
T_4	0.8 - 2
TSH	0.4 - 6

Source: Own authorship.

Ethical Approval

The study was approved by University of Baghdad Institutional Review Board, Baghdad, Iraq (reference No. 0854; 22 March 2025), and was conducted in accordance with the Declaration of Helsinki and its 2024 revision. Written informed consent was obtained from the parents or legal guardians of all participating children, and age-appropriate assent was obtained from the children before sample collection and study procedures.

Results and Discussion

The results of medical cytogenetic analyses for the studied samples are shown in Table 2, and Figures 2 and 3.

Table 2. Karyotype of patients.

sample	Karyotype	Abnormal cell	Normal cell	Percentage
1	mos47,XY,+ 21 [4]/46,XY[45]	4	45	8.16
2	mos47,XY,+ 21 [4]/46,XY[43]	4	43	8.51

3	mos47,XY,+ 21 **[5]**/46,XY**[50]**	5	50	9.09
4	mos47,XY,+ 21**[4]**/46,XY**[39]**	4	39	9.30
5	mos47,XY,+ 21 **[5]**/46,XY**[45]**	5	45	10
6	mos47,XY,+ 21 **[5]**/46,XY**[43]**	5	43	10.41
7	mos47,XY,+ 21 **[6]**/46,XY**[50]**	6	50	10.71
8	mos47,XY,+ 21 **[5]**/46,XY**[40]**	5	40	11.11
9	mos47,XY,+ 21 **[6]**/46,XY**[46]**	6	46	11.53
10	mos47,XY,+ 21 **[5]**/46,XY**[37]**	5	37	11.90
11	mos47,XY,+ 21 **[4]**/46,XY**[29]**	4	29	12.12
12	mos47,XY,+ 21 **[6]**/46,XY**[41]**	6	41	12.76
13	mos47,XY,+ 21 **[5]**/46,XY**[31]**	5	31	13.88
14	mos47,XY,+ 21 **[8]**/46,XY**[43]**	8	43	15.68
15	mos47,XY,+ 21 **[6]**/46,XY**[31]**	6	31	16.21
16	mos47,XY,+ 21 **[9]**/46,XY**[42]**	9	42	17.64
17	mos47,XY,+ 21 **[8]**/46,XY**[36]**	8	36	18.18
18	mos47,XY,+ 21 **[7]**/46,XY**[29]**	7	29	19.44
19	mos47,XY,+21 **[11]**/46,XY**[31]**	11	31	26.19
20	mos47,XY,+21 **[10]**/46,XY**[21]**	10	21	32.25

Source: Own authorship.

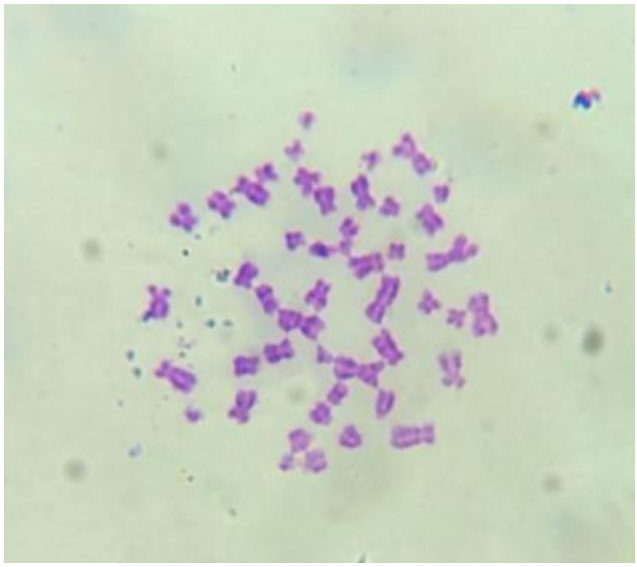

Figure 2. Down syndrome cell 47,XY,+21 G band, X=100. Source: Own authorship.

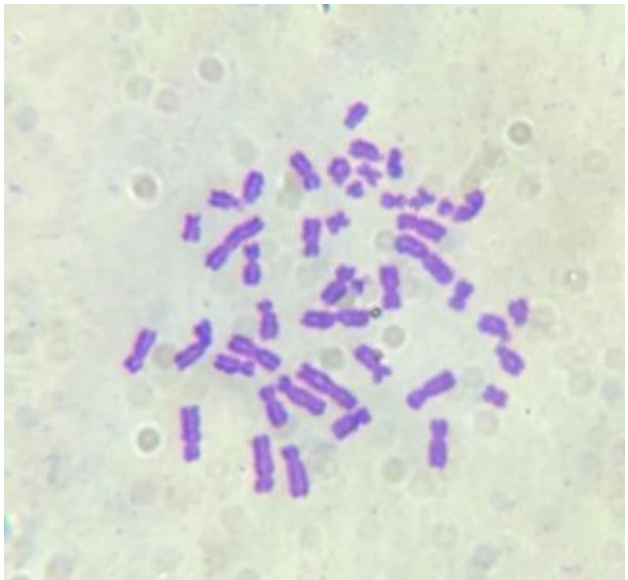

Figure 3. Normal cell 46,XY
For the same patient, G band, X=100
Source: Own authorship.

The results for thyroid hormone levels were compared with the percentage of mosaicism, as shown in Table 3 and 4.

Table 3. Mosaicism percentage and thyroid hormone levels.

Sample	Percentage	T3	T4	TSH
1	8.16	57	0.75	0.35
2	8.51	55	0.73	0.34
3	9.09	54	0.72	0.33
4	9.30	54	0.71	0.31
5	10	52	0.69	0.3
6	10.41	51	0.67	0.3
7	10.71	50	0.66	0.29
8	11.11	49	0.64	0.28
9	11.53	48	0.63	0.27
10	11.90	47	0.62	0.27
11	12.12	46	0.61	0.26
12	12.76	45	0.59	0.25
13	13.88	44	0.57	0.24
14	15.68	41	0.55	0.23
15	16.21	38	0.49	0.18
16	17.64	30	0.4	0.13
17	18.18	28	0.32	0.09
18	19.44	24	0.21	0.05
19	26.19	17	0.1	0.01
20	32.25	9	0.01	undetectable

Source: Own authorship.

Table 4. Shows the of sister chromatids exchanges in patients with mosaic down syndrome as a comparison with the control.

Mean sister chromatid exchange (exchange/50 cells) ± standard error for patients	Mean sister chromatid exchange (exchange/50 cells) ± standard error for control
62.46 ±6.12	41.61 ± 4.84

Source: Own authorship.

As shown in Tables 2 and 3, the higher the mosaicism rate was, the lower the percentage of thyroid hormones, and vice versa. The lower the mosaicism percentage was, the greater the percentage of thyroid hormones, and it was closer to the normal values. This means that there is an inverse correlation between the percentage of mosaicism and the levels of thyroid gland hormones. The results showed that the mosaicism percentage for the first sample was 8.16%, which was the lowest mosaicism percentage sample but had the highest value for thyroid hormones, as the percentage of T3 hormone was 57 ng/dL, the percentage of T4 hormone 0.75 ng/dL, and the percentage of TSH hormone was 0.35 µU/mL. The highest mosaicism percentage was 32.25%, and the lowest values for thyroid hormones were T3 (9 ng/dL), T4 (0.01 ng/dL), and TSH, which were undetectable. There were significant differences at the probability level of $p \leq 0.1$ compared with the control group. This may be because this mosaicism affects the formation of the thyroid gland and thus affects the production of

thyroid hormones through the immaturity of the gland cells.

These results are identical to what was obtained by **[15]** when they conducted their research on a sample of people with Mosaic Down syndrome in southern India and showed that 31.2% of them suffered from total hypothyroidism, and the results were consistent with what was obtained by **[16]** when they conducted their research. They found that patients with Down syndrome all had an underactive thyroid gland, and those with mosaic disease had hypothyroidism. Their rate was 96%, which was identical to what was obtained by **[17]** when they conducted their research in a hospital in Riyadh looked at patients with complete Down syndrome, and a portion of them were affected by mosaicism, as all of those with complete syndrome had hypothyroidism glands.

The incidence of mosaicism was based on the percentage of mosaicism, which is identical to what **[18]** was obtained when they conducted their research on patients with complete Down syndrome and mosaicism; all complete Down syndrome patients had hypothyroidism, while those with mosaicism and thyroid disease had hypothyroidism but in a gradually became more common relative to mosaicism.

Table 4 shows that there are significant differences in sister chromatids exchanges for the patient group, as the percentage was (62.46 ± 6.12) compared to the control group (41.61 ± 4.84), these results were consistent with what **[19]** obtained when they investigated the relationship between sister chromatid exchange and individuals with Down syndrome, and also consistent with what **[20]** obtained when they conducted their experiments on individuals with mosaic Down syndrome, where the percentage of exchange increased with the degree of mosaicism.

The results of the effect of honey on the effectiveness of honey on those with hypothyroidism were significant differences, as feeding on honey raised the percentage of thyroid hormones. These results were consistent with what was obtained by **[21]** when they conducted their study on patients with hypothyroidism who had weak sperm, as it increased the effectiveness of both, and also consistent with what was obtained by **[22]** when the effectiveness of honey was applied to hypothyroidism, and the results were positive, as honey raised the percentage of thyroid hormones.

Conclusion

All patients with Mosaic Down syndrome have hypothyroidism, and the rate of decline in thyroid hormones increases further as the percentage of mosaicism increases. The higher the degree of mosaicism, the higher the rate of sister chromatid exchange, honey has been shown to raise the level of thyroid hormones in the blood of patients with hypothyroidism.

CRediT

Author contributions: Conceptualization; Data Curating; Formal Analysis; and Investigation; Project Administration; Supervision; Writing - Original Draft: Qutaiba Hommadi Mahmood Al-Samarraie

Acknowledgment

Not applicable.

Ethical Approval

The study was approved by University of Baghdad Institutional Review Board, Baghdad, Iraq (reference No. 0854; 22 March 2025), in accordance with the Declaration of Helsinki and its 2024 revision.

Informed Consent

Written informed consent was obtained from the parents or legal guardians of all participating children. Age-appropriate assent was also obtained from the children before sample collection and participation in the study.

Funding

Not applicable.

Data Sharing Statement

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request, and all data is stored following privacy and ethical guidelines.

Conflict of Interest

The authors declare no competing interests.

Similarity Check

It was applied by Ithenticate[@].

Application of Artificial Intelligence (AI)

Not applicable.

Peer Review Process

It was performed.

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