

## Reproductive Behavior of Female University Students in Relation to Endocrine Regulators Concentration in Blood Plasma during Ovarian Cycle Phases

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Rec date: Dec 18, 2015; Acc date: Jan 04, 2016; Pub date: Jan 09, 2016

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### Abstract

The aim of our work based on answers of Slovak women - university students that are representing an important target group, was to analyse their reproductive behaviour and opinions, because the behaviour and opinions concerning reproduction could differ significantly depending also on education. Our goal was to analyze associations among reproductive behaviour of university student girls, their opinions and concentrations of endocrine regulators (insulin-like growth factors IGF-1, estradiol, testosterone and progesterone) in the blood serum and record their changes during the ovarian cycle. The group under study encompassed 301 female university students aged  $19 \pm 1.371$  years. Analysis of reproductive behaviour characteristics were based on a questionnaire method. Concentrations of the IGF-1, testosterone, estradiol and progesterone in blood plasma according to ovarian cycle phase had been set by biochemical methods and then linked with reproductive behaviour. Average value of sexual debut for girls was  $17.21 \pm 1.31$  years. Most of them get over their first sexual intercourse in the age of 19 and almost half of them had one sexual partner. Differences in hormone concentrations were proved according to ovarian cycle phase for estradiol and progesterone, but no differences were found for testosterone; physiological role of IGF-1 during ovarian cycle did not alternate. IGF-1 influenced regulation of female students' opinion of optimum age for sexual life beginning, their attitude to gender identity and marriage planning. Satisfaction with sexual identity was associated with higher blood estradiol level (but not with testosterone and progesterone levels). The outputs given in this work can help identifying insufficiently known relations between less known endocrine regulators (IGF-1) and reproductive behaviour of young women. Practical results are assumed e.g. in possible screening tests, diagnostics and subsequent troubleshooting concerning the reproduction behaviour of young women.

**Keywords:** Insulin-like growth factor IGF-1; Estradiol; Testosterone; Progesterone; Reproductive behavior; Female university students

### Introduction

Scientists involved in the growth and evolution of man are agreed that during the second decade of human life (adolescence period) numerous biological, psychic and social changes occur, which bring also development of sexuality and reproductive behavior [1-4]. Human reproductive behavior is determined by biological dispositions, but its actual manifestations could be substantially modified by external circumstances and it is characterized by three life milestones – first sexual intercourse (sexual debut), marriage and birth of first child [5]. In general, we could say that acceleration of the rhythm of life, deepening of educational processes, more breaking of young people from their parents, availability of information relating to sex life and also existence of effective contraception are phenomenon contributing to earlier beginning of sexual life. Data in the literature can prove that the average age of sexual debut is declining [4,6,7] and depending on various factors, e.g. education, religion, abode, etc. During the fetal and

neonatal life, rather high concentration of hormones, testosterone mainly, influences brain development and gender-specific behavior.

This phenomenon has been primarily evaluated in rodents as well as in primates and other mammals. The hypothalamus, hippocampus and limbic system appear to be an important aim of sex steroids [8,9]. These brain structures and from here controlled behavior are then activated at the beginning of puberty, when production of the sex steroid hormones rises [10]. The hormones can influence behavior and vice versa – the behavior (reproductive behavior, physical activity, stress, alcohol and nutrition) can influence the hormone levels [11]. Important part in the reproductive behavior is played by reproductive endocrine regulators (androgens, estrogens, progesterone). During puberty the sexual appetite is triggered by hormones (inner factors); in adolescence mainly relations (external factors) are relevant. Estrogens are classed as female hormones together with estradiol, estrone and estrin [12]. In addition to other functions, estrogens influence also mental development for feminine type [13] and among all sex hormones have the greatest impact on mood [14]. Estradiol is a sex steroid hormone, primarily produced by ovaries, but it can be produced also locally by various tissues by changing testosterone into estrogen and subsequently by aromatases to estradiol [15]. Estradiol

stimulates reproductive organs to grow and function and it affects growth of secondary sex characteristics and feminine fat distribution model [16]. Less of recently published research deals with the estrogen role in adolescent sexuality, but some of them point to the impact of estrogen on the sexual behavior of adolescent girls [17]. With hypogonadal adolescent girls estrogens positively influenced their reproductive behavior [18]. Irving et al. [19] point out that in measuring the blood testosterone or estrogens it is not clear, which of them was primary or secondary in reproductive behavior as testosterone can be converted into estrogen. Some authors quote progesterone to mediate signals needed for sexual behavior [20].

Testosterone in women is associated with mood changes during the menstrual cycle, at high levels it results in negative feelings and depression [21-23]. It is created by conversion of androstenedione; another place of its production are the ovaries and adrenal cortex [24-26]. Creation of testosterone also takes place in brain cells [26]. During pregnancy, testosterone is produced by the placenta [27]. Besides steroidal sex hormones, a group of peptide hormones that are growth factors is relevant in growth processes, such as the insulin-like growth factor IGF-1, which belongs to the IGF family that includes insulin, IGF-1 and IGF-2 [28]. IGF has a wide range of metabolic and developmental functions, including embryogenesis and postnatal organogenesis [29]. In humans, the IGF-1 serum concentration is related to age and it increases slowly from birth to adolescence [30], where it culminates and then slowly decreases with increasing age and is in contrast to IGF-2, the serum concentration of which is virtually unchanged from birth to adulthood. Hormone IGF-1 plays an important role not only in the growth of organism, but also in many other biological, psychic and other effects. Connection of its hormonal effects with physical and emotional changes and clarification of these effects could elucidate the biological role of the IGF-1 at different stages of ontogenetic development and help solve the issue of human growth, reproductive and social behavior or regimen.

The aim of our work based on answers of Slovak women - university students that are representing an important target group, was to analyze their reproductive behavior and opinions, because the behavior and opinions concerning reproduction could differ significantly depending also on education. Other aims of the work were to characterize endocrine regulators (IGF-1, estradiol, testosterone and progesterone) in the blood serum and record their changes during the ovarian cycle. We wanted to verify whether there is a correlation between concentrations of these hormones and selected elements of reproductive behavior; this way we would like to deepen knowledge about the biological function of hormones IGF-1, estradiol, testosterone and progesterone. In particular, the associations among IGF-1, reproductive behavior and opinions are missing in the available literature.

We believe that it is necessary to know the real reproductive behavior of Slovak young women – university students and their opinions to optimize reproductive health and increase possibilities and modalities of information on sexual and reproductive health. These data have to be updated continually, as they may change with time, age, living conditions, education,

## Materials and Methods

This survey was a cross sectional study. Data was collected in April-July 2014. Participation of these female students was voluntary. Target study population included 301 female students of the first year of the

Constantine the Philosopher University in Nitra at the age of  $19 \pm 1.371$  years. It was an ethnically homogenous group consisting of young women of Slovak nationality who came from various regions of Slovak Republic. The women were selected at random. Recruitment was carried out by research assistants, and students. At first, an interview was conducted with the women, in which we investigated their health and informed them of the research aim. Only healthy women with regular menstrual cycle participated in the research (women with history of chronic respiratory illnesses, endocrine disorders, immunodeficiency, renal disease, neurologic were excluded).

The women who admitted having used any drugs were excluded from the research. No women taking hormonal contraceptives were included in the research. In accordance with the Helsinki Declaration 1975, obtaining the written permission of the female students for a blood collection, the questionnaire investigation and processing the results was a vital condition. 117 female students agreed with the blood collection and subsequent biochemical analysis. Completed anonymous questionnaires were used for analysis of selected elements of reproductive behavior of young women (sexual debut, number of sexual partners), but also for analysis of their opinions concerning contentment/discontentment with their own feminine sexual identity, optimum age for sexual debut and marriage. Willingness of the women to answer the questionnaire with intimate questions varied in spite of the fact that anonymity was respected. Some female respondents did not answer all questions in the questionnaire.

Concentrations of endocrine regulators IGF-1, testosterone, estradiol and progesterone in the blood serum were set by biochemical methods. Before their blood was collected, the women have answered the date of last menstrual period and the length of menstrual cycle. These data were needed to set the phase (follicular/luteal) of ovarian cycle. The blood samples were processed at the accredited workplace of the Department of Nursing, Faculty of Social Sciences and Health, Constantine the Philosopher University in Nitra. The women were on an empty stomach and the blood samples were taken by certificated nurses in sterile conditions during the morning hours from 7.00 to 9.00 a.m. Subsequently the samples were processed at the biochemical laboratory. The blood was centrifuged  $\times 300g$  and the blood plasma was refrigerated under  $-70^{\circ}C$ . The hormone concentrations (IGF-1, testosterone, progesterone and estradiol) in the blood serum were set by the RIA (radioimmunoassay) method with Imunotech commercial sets according to the producer's instructions.

The hormone concentrations in the blood serum were assessed in a duplicate with the acidethanol extraction by the IRMA method. We used the DSL commercial set (Webster, TX, USA) according to the producer's instructions. All analytical kits were designed to determine women's blood and they contained plasma reference samples for validation of measured values and calibration curves. The IGF set sensitivity was 0.3 ng/ml. The intraassay variation coefficient was  $<3.4\%$ . The interassay variation coefficient was  $<8.2\%$ . Estradiol set sensitivity was 6.0 pg/ml. The intraassay variation coefficient was  $<12.1\%$ . The interassay variation coefficient was  $<11.2\%$ . Progesterone set sensitivity was 0.05 ng/ml. The intraassay variation coefficient was  $<5.8\%$ . The interassay variation coefficient was  $<9\%$ . Testosterone set sensitivity was 0.025 ng/ml. The intraassay variation coefficient was  $<14.8\%$ . The interassay variation coefficient was  $<15.0\%$ .

## Data Analysis

In the research, measurement results were processed by mathematical and statistical analysis. In each group (group of students with under- and above-average values of the individual characteristics) mean  $\pm$  S.E.M were calculated. Significant differences in plasma steroid hormones and IGF-1 concentration between the groups were evaluated at level of significance  $*p \leq 0.05$  (5%). Mathematical and statistical analyses were determined using statistical package Statistica 7 cz (Statsoft, Prague, Czech republic).

## Results

### The group reproductive characteristics

Regarding the reproductive characteristics of the group under research, we learned that at the age of 20, 75% (n=228) have got their sexual debut over. Twenty eight girls (9%) had their sexual intercourse at the age of 15. Average age of the sexual debut in the group under study was  $17.21 \pm 1.31$  years. We can say that 127 of them (42%) behaved risk as we considered the sexual debut under the age of 18 to be risk behavior (Table 1). Another indicator of sexual behavior was number of existing sexual partners (Table 2), which ranged from one to fourteen (1 woman). One sexual partner was the most common response (n=99.33%).

Age of sexual debut/years	$\leq 15$	16	17	18	19	20	None
Number of girls	28	41	58	63	31	7	73
Number of girls in%	9	14	19	21	10	2	25
x $\pm$ SD	17.21 $\pm$ 1.31 years						
x: Arithmetic Average; SD: Standard Deviation							

**Table 1:** Age of sexual debut.

Number of sexual partners	0	1	2	3	4	5	6	7	8	9	$\geq 10$
Number of girls	73	99	58	28	14	9	8	5	1	2	4
Number of girls in%	24	33	19	9	5	3	3	2	0.4	0.6	1
x: Arithmetic Average; SD: Standard Deviation											

**Table 2:** Number of existing sexual partners.

### Opinions on reproductive behavior

In the second part we investigated the women's opinions concerning the reproductive behavior. Nearly half of the girls (n=136; 45%) believe the age between 15-17 years to be appropriate for sexual debut. Interesting finding was that 11 girls (4%) deem the right time for sexual debut is after the marriage (Table 3). In opinions concerning the optimum reproductive behavior, views consistent with the society-wide acceptable patterns were prevailing. Sexual activity of many women, however, appears earlier than they themselves consider optimum. Opinions on the appropriate start of sexual debut of women are also related to the age of respondents, while it is expected that at

lower ages, this line moves downward. Majority of the female students (n=264; 87.5%) has future marriage plans, 37 (12.5%) is not decided yet. According to the wishes of the majority of respondents (n=124; 41%) optimal age for the marriage is 25-26 years of life (Table 4).

Age/years	$\leq 15$	15-17	18-19	20-21	22-24	>24	After marriage
Number of students	4	88	136	40	8	14	11
Number of Students in %	1	29	45	13	3	5	4

**Table 3:** Opinions of the respondents on optimal age for sexual debut.

Age in which they wish to marry	Number	%
22 years	9	3
23-24 years	35	12
25-26 years	124	41
27-28 years	58	19
29-32 years	37	12
33-35 years	1	0.5
Undecided	37	12.5

**Table 4:** Opinions of the respondents on the assumed age of marriage.

### Hormonal characteristics of the group under study

Concentrations of estradiol, progesterone, testosterone and IGF-1 that we have found are given in the Table 5. These values range within the standard values as they are presented by the RIA kits producer [31]. In our work we presume to be first who monitored the connection between the ovarian cycle phases and IGF-1 concentrations. No significant difference in the blood IGF-1 concentrations in the follicular and luteal phase of the ovarian cycle of the students under investigation was found. This can indicate that no change in physiological role of IGF-1 takes place in the ovarian cycle; we therefore further associations of IGF-1 with the indicators of reproductive behavior made of the total concentration of IGF-1 in the blood plasma of young women. Average concentration of estradiol in the luteal phase was 226.05 pg/ml, which is 145.95 pg/ml more than in the follicular phase; this difference is statistically significant ( $p \leq 0.05$ ). Comparison of progesterone concentrations showed a significant difference between follicular and luteal phase of the ovarian cycle ( $p \leq 0.05$ ). Progesterone concentration in the luteal phase was 5.93 ng/ml, which is 4.71 ng/ml more than in the follicular phase. Average concentration of testosterone in the both phases was 0.37 ng/ml, which is insignificant difference statistically.

Follicular phase of the cycle		Luteal phase of the cycle	
Hormone	x $\pm$ SD	Hormone	x $\pm$ SD
Estradiol	80.10 $\pm$ 4.42*	Estradiol	226.05 $\pm$ 5.73*
Progesterone	1.22 $\pm$ 0.38*	Progesterone	5.93 $\pm$ 0.94*
Testosterone	0.37 $\pm$ 0.12	Testosterone	0.37 $\pm$ 0.11

IGF-1	850.38 ± 33.25	IGF-1	848.55 ± 31.23
x: Arithmetic Average; SD: Standard Deviation; *Statistically proved difference (p ≤ 0.05)			

**Table 5:** Average concentrations of estradiol (pg/ml), progesterone (ng/ml), testosterone (ng/ml) and IFG-I (ng/ml) in the follicular and luteal phases of ovarian cycle.

### Reproductive behavior and opinions in relation to blood hormone concentrations

Concentrations of the hormones in relation to answers on reproductive behavior of the young women are presented in the Table 6. We found no significant difference in IGF-1 concentration in the blood plasma with women that already had (884.67 ± 39.13) or had not

(823.76 ± 73.04) sexual intercourse nor with women with below-average (before the age of 18) or above-average (after the age of 18) age of sexual debut (872.19 ± 48.39 or 901.06 ± 65.27). Similarly, no significant difference was found in IGF-1 concentration in the blood plasma (887.61 ± 45.03 or 905.09 ± 78.36) regarding existing sexual partners (less than or three partners and more than three partners). Concentration of IGF-1 hormone in the blood serum was significantly higher (p ≤ 0.05) with women whose opinion is that the optimum age for sexual debut is to the age of 18 than those whose opinion is that the optimum age for sexual debut is more than 18 years of life. Evaluating relations between hormone concentrations and opinions of the students under study (contentment/discontentment with gender identity), conclusive differences were found. The women contented with their gender identity had significantly lesser concentration of IGF-1 in their blood plasma (p ≤ 0.05) and significantly higher concentration of estradiol (p ≤ 0.05).

Have you had sexual intercourse?		
	Yes	No
	x ± SD	x ± SD
IGF-1 (ng/ml)	884.67 ± 39.13	823.76 ± 73.04
Estradiol (f.ph.)	81.40 ± 4.90	79.45 ± 5.30
Estradiol (l.ph.)	227.35 ± 5.80	225.23 ± 5.51
Testosterone (f.ph.)	0.37 ± 0.11	0.37 ± 0.11
Testosterone (l.ph.)	0.37 ± 0.10	0.37 ± 0.11
Progesterone(f.ph.)	1.31 ± 0.72	1.15 ± 0.45
Progesterone (l.ph.)	6.04 ± 0.86	5.96 ± 0.91
Real age of sexual debut		
	≤ 18 years	≥ 18 years
	x ± SD	x ± SD
IGF-1 (ng/ml)	872.19 ± 48.39	901.06 ± 65.27
Estradiol (f.ph.)	80.34 ± 4.70	80.45 ± 4.50
Estradiol (l.ph.)	227.52 ± 5.80	225.79±5.51
Testosterone (f.ph.)	0.37 ± 0.11	0.37 ± 0.11
Testosterone (l.ph.)	0.37 ± 0.10	0.37 ± 0.11
Progesterone (f.ph.)	1.34 ± 0.98	1.28 ± 0.91
Progesterone (l.ph.)	5.88 ± 0.55	5.73 ± 0.87
Opinion on age of sexual debut		
	≤ 18 years	≥ 18 years
IGF-1 (ng/ml)	836.69 ± 42.82	620.67± 46.36*
Opinion on future marriage		
	Planning to marry	Undecided
IGF-1 (ng/ml)	858.40 ± 33.23	456.50 ± 66.77*

<b>Number of sexual partners</b>		
	<b>1-3 partners</b>	<b>More than 3 partners</b>
	x ± SD	x ± SD
IGF-1 (ng/ml)	887.61 ± 45.03	905.09 ± 78.36
Estradiol (f.ph.)	83.65 ± 5.86	80.78 ± 3.99
Estradiol (l.ph.)	225.01 ± 4.11	225.09 ± 5.30
Testosterone (f.ph.)	0.37 ± 0.11	0.38 ± 0.16
Testosterone (l.ph.)	0.37 ± 0.11	0.38 ± 0.18
Progesterone (f.ph.)	1.37 ± 0.69	1.18 ± 0.89
Progesterone (l.ph.)	5.83 ± 0.71	5.61 ± 0.89
<b>Contentment with gender identity</b>		
	<b>Contented</b>	<b>Discontented</b>
	x ± SD	x ± SD
IGF-1 (ng/ml)	860.18 ± 34.60	1072.84 ± 37.10*
Estradiol (f.ph.)	90.52 ± 4.77	70.22 ± 4.11*
Estradiol (l.ph.)	236.14 ± 6.40	216.23 ± 5.7*
Testosterone (f.ph.)	0.37 ± 0.11	0.37 ± 0.13
Testosterone (l.ph.)	0.36 ± 0.12	0.38 ± 0.14
Progesterone (f.ph.)	1.24 ± 0.95	1.28 ± 0.91
Progesterone (l.ph.)	5.68 ± 0.65	5.90 ± 0.83
x: Arithmetic Average; SD: Standard Deviation;		
*Statistically proved difference (p ≤ 0.05); l.ph.: Luteal Phase; f.ph.: Follicular Phase		

**Table 6:** Comparison of hormone concentrations (IGF-1, estradiol, testosterone, progesterone) in the blood plasma in questions on reproductive behavior and opinions.

## Discussion

In our study, we analysed selected aspects of reproductive behavior and some opinions on reproductive behavior among female university students. We evaluated associations between concentrations of endocrine regulators (IGF-1, estradiol, testosterone and progesterone) and characteristics of reproductive behavior. Sexual debut is believed to be the basic indicator of reproductive behavior that can have a decisive impact on sexual behavior of the individual. We found that at the age of 19, majority of women have already got over their first sexual intercourse; average age of sexual debut was  $17.21 \pm 1.31$  years and almost a half of the students had only one existing partner. Similar study was carried out in 1996 by Slovak FOCUS agency with women at the age of 15-44 years [32]. According to their results, 84.1% of the women got over their sexual debut; average age of the first sexual intercourse was 18 years. Our results cooperate with those that were obtained by the FOCUS agency, the results are similar and slight variations can be caused by wider age scale of the women studied by the FOCUS agency.

Overall and base on our observations, we can state that with Slovak women the age of sexual debut ranges between 17 to 18 years, but

according to the respondents' opinion it could be 18-19 years. Age of sexual debut depends on different factors (level of education, social and economic status, religion, residence, etc.) and that's why the results can differ significantly in various countries or populations. Median age of sexual debut according to the study of adolescent women in South Africa was 16 years [33], prevalence of early sexual debut in the group of Nepal adolescent women was 39.2% and their average age was 17.9 years [34]. In the USA, average age of sexual debut dropped to 16.2 years while the research in the group of girls at the age of 14-19 showed that 45.2% of them had sexual intercourse already [4]. In Denmark, women and men born before 1920 got over their sexual debut at the average age of 21 and 20 years respectively. In the present days, median age of sexual debut is 16 years with the both sexes [6]. Individuals with earlier sexual debut are more predisposed to risk behavior that may result in higher incidence of sexually transmitted infections STI/HIV [34]. Research in the group of 785 German adolescent girls proved that 70% of them got over their sexual debut before the age of 18, but less than 5% of them were younger than 14 years [35]. Results of the research in group of Greek adolescent girls documented the average age of sexual debut at the age of  $14.5 \pm 0.9$  years [36].

Apart from the reproductive behavior, we evaluated also opinions of the female university students under study in our study. We found that majority of them consider the age of 18 to be optimum for sexual debut and one sexual partner optimum in life. Most of them is contented with their female gender identity and plan marriage in future. According to the FOCUS agency results [32] more than 70% of female respondents take the view sexual activity of women should begin up to 19 years of age. Our results therefore correspond with those obtained by the FOCUS agency, which might suggest that reproductive behavior and opinions of Slovak women have not changed within the last 17 years.

The hormone concentrations (IGF-1, estradiol, testosterone and progesterone) in the blood plasma we have found ranges within standard values. We found no significant difference in IGF-1 level in the blood in follicular and luteal phases of ovarian cycle. We suppose physiological role of IGF-1 during the ovarian cycle does not change. We found no associations between reproductive behavior (characterized by age of sexual debut and number of sexual partners) and concentration of IGF-1 in the blood serum. There is information in available literature that demonstrates relations among sexuality, reproductive behavior and concentrations of sex steroid hormones, e.g. there are publications describing positive experience between increased testosterone concentration and increased interest in the opposite sex and higher number of sexual partners [37] with men, but no relation was proved between testosterone concentration and increased number of sexual partners with women. High testosterone concentration can increase sexual activity with hyperandrogenic women; with healthy women no relation between testosterone level and sexual behavior was found [38].

With women, testosterone can influence their mood during the menstrual cycle [38,39]. High progesterone concentration can lead to decreased sex drive; estrogen affects sexuality while influencing mood and well-being [38]. We found no physiological conception based on linking the reproductive behavior with IGF-1 concentration in available literature, though such possible associations are pondered. One of possible physiological explanations could be in cooperation between IGF-1 hormone and steroid hormones as it was observed with rats [40]. Our work does not prove this possible functional link unambiguously, what can be caused by different observation objects, however, certain relations are indicated. We found that IGF-1 concentration is significantly higher with women who consider the age to 18 to be optimum for sexual debut, with women discontent with their female gender identity and with those planning future marriage. In other opinions of the young women on reproductive behavior (number of sexual partners, age at marriage) we learned no association with IGF-1 concentration. We believe we are first who have investigated these relations as no similar treatise was found in existing literature. Physiological conception that could explain these complex relations needs more detailed investigations. Our results demonstrate that IGF-1 can participate in regulation of attitude of young women to particular characteristics of reproductive behavior (the questions under our investigation – optimum age of sexual debut, contentment with female gender identity and view on planning of future marriage).

## Conclusions

In our work we proved differences in hormone concentrations in relation to ovarian cycle phases with estradiol and progesterone, but not with testosterone; physiological role of IGF-1 during the ovarian cycle does not change. IGF-1 participates in regulation of opinions of

young women on optimum age of sexual debut; it impacts contentment with their gender identity and planning of future marriage. Contentment with gender identity is associated with higher level of estradiol in the blood plasma (but not testosterone and progesterone). Results of our work can help clarify insufficiently known relations between less known endocrine regulators (IGF-1) and reproductive behavior of young women. In practice, the results achieved are presupposed to be applied e.g. in possible screenings, diagnostics and subsequent solving of problems in reproductive behavior. Actual knowledge of reproductive behavior of young women can be useful also for parents, educators, health professionals, doctors in reproductive health protection. The work can contribute to understanding the role of IGF-1 in control of individual physiological phenomena (except from the already known role in growth, also in possible association with reproductive behavior). Based on these results, new approaches could be found to characteristics, prediction and correction in development of these phenomena based on changes of IGF-1 levels in the blood. The work can be a great asset also to medicine (treatment of morpho-physiological, psychiatric and reproductive disorders). Last but not least the results can help in endocrinology to enrich the knowledge of steroid hormones impacts and also that of less known endocrine regulators (IGF-1). A physiological conception that could explain complex relations between IGF-1 concentrations a reproductive behavior requires further more detailed studies.

## Competing Interests

The authors declare that they have no competing interests.

## Acknowledgement

Our thanks go to Department of Nursing, Faculty of Social Sciences and Health, Constantine the Philosopher University in Nitra and Animal Production Research Centre laboratory in Nitra.

## References

1. Moore S, Rosenthal D (1993) *Sexuality in Adolescence (Adolescence and Society)*. Routledge, London.
2. Kipke MD (1999) *Adolescent development and the biology of puberty: summary of a workshop on new research*. National Academies Press.
3. Steinberg L (1998) *Adolescence*. (5ndedn) McGraw–Hill College.
4. Liu G, Hariri S, Bradley H, Gottlieb SL, Leichter JS, et al. (2015) Trends and patterns of sexual behaviors among adolescents and adults aged 14 to 59 years, United States. *Sex Transm Dis*; 42: 20-26.
5. Nieschlag E, Behre HM (2004) *Testosterone: action, deficiency, substitution*. (3ndedn) Cambridge University Press.
6. Stryhn JG, Graugaard C (2014) The age at first intercourse has been stable since the 1960s, and early coital debut is linked to sexual risk situations. *Ugeskr Laeger*; 8,176.
7. Gayet C, Gutiérrez JP (2014) Sexual debut in Mexico: a comparison of household national surveys. *Salud Publica Mex*; 56: 638-647.
8. Bettini E, Pollio G, Santagati S, Maggi A (1992) Estrogen receptor in rat brain: Presence in the hippocampal formation. *Neuroendocrinology*; 56: 502-508.
9. Collaer ML, Hines M (1995) Human behavioral sex differences: a role for gonadal hormones during early development? *Psychol Bull*; 118: 55-107.
10. Archer J (1991) The influence of testosterone on human aggression, *Br J Psychol*; 83: 1-28.
11. Christiansen K (1999) *Die Hypophysen–Gonaden–Achse (Mann)*. *Psychoendokrinologie und Psychoimmunologie, Enzyklopädie der*

- Psychologie, D. HELLHAMMER & C. KIRSCHBAUM, Hogrefe, Göttingen.
12. Mathews CK, Van Holde KE, Ahern KG (1999) *Biochemistry*. (3rd edn) Addison Wesley Longman, San Francisco.
  13. Rebar RW (2009) Premature ovarian failure. *Obstet Gynecol*; 113: 1355-1363.
  14. Shepherd JE (2001) Effects of Estrogen on Cognition, Mood, and Degenerative Brain Diseases. *J Am Pharm Assoc*; 41.
  15. Roselli CE, Horton LE, Resko JA (1985) Distribution and regulation of aromatase activity in the rat hypothalamus and limbic system. *Endocrinology*; 117: 2471-2477.
  16. Creager JG (1992) *Human Anatomy and Physiology*. Wm. C. Brown Publishers, USA.
  17. Weiner IB, Lerner RM, Easterbrooks MA (2003). *Handbook of Psychology*, volume 6, Developmental psychology. Wiley and Sons.
  18. Finkelstein JW, Susman EJ, Chincilli WM, Kunselman SJ, D'Arcangelo MR, et al. (1997) Estrogen or testosterone increases self-reported aggressive behaviors in hypogonadal adolescents. *J Clin Endocrinol Metab*; 82: 2433-2438.
  19. Irving LM, Wall M, Neumark-Sztainer D, Story M (2002) Steroid use among adolescents: findings from Project EAT. *J Adolesc Health*; 30:243-252.
  20. Graham JD, Clarke CHL (1997) Physiological Action of Progesterone in Target Tissues. *Endocrine Reviews*; (18): 4.
  21. Crammer JL (1986) Premenstrual depression, cortisol and oestradiol treatment. *Psychol Med*; 16: 451-455.
  22. Dewis P, Newman M, Ratcliffe WA, Anderson DC (1986) Does testosterone affect the normal menstrual cycle? *Clin Endocrinol*; 24:515-521.
  23. Burd ID, Bachmann GA (2001) Androgen replacement in menopause. *Curr Womens Health Rep*; 1: 202-205.
  24. Regelson W, Colman C (1996) *The Super-Hormone Promise*. Simon & Schuster Inc, New York.
  25. Speroff L, Glass RH, Kase NG (1994) *Clinical gynecologic endocrinology and infertility*. (5th edn) Williams & Wilkins, Baltimore.
  26. Baulieu EE (1997) Neurosteroids: of the nervous system, by the nervous system, for the nervous system. *Rec Prog Horm Res*; 52: 1-32.
  27. Norman AW, Litwack G (1997) *Hormones*, (2nd edn) CA: Academic Press, San Diego.
  28. Werner H, LeRoith D (2000) New concepts in regulation and function of insulin-like growth factors: implications for understanding normal growth and neoplasia. *Cell Mol Life Sci*; 57: 932-942.
  29. Jones JI, Clemmons DR (1995) Insulin-like growth factors and their binding proteins: biological actions. *Endocr Rev*; 16: 3-34.
  30. Yamada M, Hasegawa T, Hasegawa Y (1998) Increase in free insulin-like growth factor - I levels in precocious and normal puberty. *Endocr J* 45: 407-412.
  31. Silbernagl S, Despopoulos A (2004) *Atlas fyziologie člověka*. Grada publishing, Praha [in Slovak].
  32. Kliment M, Cupaník V (1998) Reprodukčné správanie žien na Slovensku. *Slovenská gynekológia a pôrodnictvo*; 1: 9-12.[in Slovak]
  33. Richter L, Mabaso M, Ramjith J, Norris SA (2015) Early sexual debut: Voluntary or coerced? Evidence from longitudinal data in South Africa-the Birth to Twenty Plus study. *S Afr Med J*; 105: 304-307.
  34. Shrestha R, Karki P, Copenhagen M (2015) Early Sexual Debut: A Risk Factor for STIs/HIV Acquisition Among a Nationally Representative Sample of Adults in Nepal. *J Community Health*. [Epub ahead of print]
  35. Remschmidt C, Fesenfeld M, Kaufmann AM, Deleré Y (2014) Sexual behavior and factors associated with young age at first intercourse and HPV vaccine uptake among young women in Germany: implications for HPV vaccination policies. *BMC Public Health*; 14: 1248.
  36. Tsitsika A, Andrie E, Deligeoroglou E, Tzavara C, Sakou I, et al. (2014) Experiencing sexuality in youth living in Greece: contraceptive practices, risk taking, and psychosocial status. *J Pediatr Adolesc Gynecol*; 27: 232-239.
  37. Van Anders SM, Hamilton LD, Watson NV (2007) Multiple partners are associated with higher testosterone in North American men and women. *Hormones and Behavior*; 51: 454-459.
  38. Campbell KL, Wood JW (1994) *An introduction to quantitative endocrinology*. JW Wood Dynamics of Human Reproduction: Biology, Biometry, Demography. Hawthorne, Aldine De Gruyter, NY.
  39. Rubin RT, Reinisch JM, Haskett RF (1981) Postnatal gonadal steroid effects on human behavior. *Science*; 211:1318-1324.
  40. Lackey BR, Gray SL, Henricks DM (1999) The insulin-like growth factor (IGF) system and gonadotropin regulation: actions and interactions. *Cytokine & Growth Factor Reviews*; 10:201-217.