

Prenatal attachment by first-time fathers – the pilot study of the factor structure of the Polish-language version of the Prenatal Attachment Inventory for men (PAI-M)

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Abstract

Aim of the study: This study aims to assess the psychometric properties and factor structure of the Polish translation of Prenatal Attachment Inventory (PAI) in the male version (PAI-M).

Material and methods: A cross-sectional self-assessment study was conducted among a group of 406 Polish first-time expectant fathers during three sessions ($n=113$, $n=186$, and $n=107$, respectively). The reliability and construct validity of the PAI were evaluated. An Exploratory Factor Analysis (EFA) and a Confirmatory Factor Analysis (CFA) using Structural Equation Modelling (SEM) were conducted.

Results: The EFA extracted a three-factor structure (Feelings, Thoughts and beliefs, and Interactions and activities); its fit to the model has been confirmed by the CFA. Therefore, the final version of the PAI-M consists of 10 statements, comprising three factors, and demonstrates satisfactory internal consistency.

Discussion: The structure of PAI-M found in the current study confirms and emphasizes that the mode of experiencing pregnancy and forming an attachment to an unborn child differs between men and women. Fathers were found to be less likely to manifest attachment by sharing information about how active the baby is in the womb and found it more difficult to attribute traits to the baby during this period. They manifested prenatal attachment mainly through emotions such as joy, happiness or love.

Conclusions: The PAI-M is a reliable and valid instrument for use in Polish first-time expectant fathers to investigate the development of the paternal attachment towards the unborn child.

attachment; factor analysis; paternal–fetal attachment; paternal prenatal bonding; psychometric evaluation

INTRODUCTION

Expecting a child is a time of great challenges and new experiences and tasks for both future

parents. Rubin [1] regards the most important of these tasks to be the creation of an emotional bond with the unborn child. Previous studies emphasize that the special relationship between the mother and the child, known as *the bond*, does not manifest itself at the moment of birth, but it is shaped and developed throughout pregnancy [2, 3]. Van den Bergh and Simons

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[4] believe that the formation of a bond between mother and prenatal child is an important developmental task, and its implementation determines successful adaptation to pregnancy. Muller [5] also regards it to be a key element of pregnancy. Moreover, it has been proven that building a bond between the mother and the fetus is important for the health and well-being of both mother and child [6].

While the nature of the emotional bond that forms between mother and child throughout the perinatal period has frequently been explored, the one between father and child appears to be of less interest. However, it is not only the mother-to-be who is preparing for the new role she is to play after the birth of the baby; the development of the father-child dyad also appears to be extremely important, assuming that the formation of a positive prenatal bond with the child will allow for greater mutual acceptance.

Condon [7] and Condon et al. [8] regard the heart of a man's experience of early parenting to be paternal prenatal bonding, manifesting as a subjective feeling of love for the unborn child. Although pregnancy is a time of psychological preparation for both parents, and both – the mother and the father may feel more or less attached to their unborn child [9], some studies suggest that expecting men and women may bond differently with the prenatal child [10, 11, 12]. It is obvious that due to the biological limitations placed on the male body, the future father can only come into contact with the baby indirectly, i.e. through the actions of the baby's mother; this may be the reason why mothers tend to demonstrate greater attachment to the fetus than the fathers [13, 14].

In order to study the specificity of this bond, and the factors that influence the prenatal attachment of father to child, a paternal prenatal attachment measurement tool is needed. The solution may lie in the use of the Prenatal Attachment Inventory (PAI) developed by Muller [5], one of the most frequently used tools in research on the prenatal bond dedicated to the mother-child dyad.

In its original version, the PAI consists of 21 items that describe the mother's thoughts and feelings about the expected baby and her attitude towards it. The respondent can evaluate each of the statements on a four-point Likert scale (1=almost never; 2=sometimes; 3=often,

and 4=almost always). Attachment strength is determined by the sum of all items, with a higher score indicating a stronger attachment to the prenatal child. Originally, Muller recommended a single-factor solution [5] which was later confirmed by Gau and Lee [15]. However, a Polish-Swedish study by Bielawska-Batorowicz and Siddiqui [16] suggested a multidimensional factor solution based on Fantasy, Interaction, Sharing, Attributing traits, and Affection. Clearly, little consensus exists among researchers as to whether the PAI has a unidimensional or multidimensional structure, even in the version that measures maternal prenatal attachment.

The PAI does not appear to have been validated so far in studies involving men. As such, there is no evidence that can confirm whether a male version of the PAI has the same or a similar structure to the female version used in studies involving expectant mothers, or whether it may be completely different.

Therefore, the present study evaluates the potential of the Prenatal Attachment Inventory (PAI) [5] translated by Bielawska-Batorowicz [16] for use in fathers. More precisely, its aim is to validate the factor structure of the Polish version of the PAI and to determine its psychometric properties among first-time expectant fathers in Poland.

METHODS

Study Design

A cross-sectional design with purposive sampling was chosen for the study, which involved first-time expectant fathers in central Poland.

Inclusion/exclusion criteria

The inclusion criteria were as follows: being first-time expectant fathers, third trimester of partner's pregnancy, at least 18 years of age, lack of past or current diagnosis of any psychiatric disease, as well as signed informed consent to participate in the study. The exclusion criteria comprised having other children (biological or adopted children), current or previous mental health problems, undergoing psychiatric treatment, or a lack of informed consent.

Ethical considerations

The research was conducted in accordance with the Helsinki Declaration of Human Rights [17]. The study protocol was approved by the Research Ethics Board at the University of Łódź. The questionnaire sheets contained all the information about the study that enabled participants to give their signed informed consent: the participants were informed that the results of the study would only be used for scientific purposes, that participation was anonymous and completely voluntary, and that they could withdraw at any time without penalty.

Procedure

Work on the development of the PAI questionnaire for fathers was based on Pasquali's methodological model for constructing measurement tools, which consists of three sets of procedures: theoretical, empirical, and analytical (statistical) [18]. However, the theoretical stage was modified as the study used an existing version of a prenatal attachment measurement tool to create one that could be used for paternal bonding (Figure 1).

Phase 1 used the Polish translation and adaptation of the PAI by Bielawska-Batorowicz [16]. Items were reformulated, which required changes from female to male, eg *"I'm talking to the baby in my wife's / partner's tummy"* instead of *"I'm talking to the baby in my tummy"*.

In Phase 2, a pilot study was conducted to verify whether the one-factor structure of the PAI recommended by Muller [5] and the five-factor

structure recommended by Bielawska-Batorowicz and Siddiqui [16] also fit the data in the proposed male version. For this purpose, 113 men expecting their first child were examined (see: Table 1) with the Polish language version of the questionnaire given above, and the results were subjected to confirmatory factor analysis (CFA). As expected, the one-factor and five-factor structures of the questionnaire for mothers turned out to be mismatched to the fathers' experiences and the understanding of relationships with regard to expecting a child. More detailed results are given in the Results section.

Therefore, a team of eight competent judges was appointed. This consisted of two fathers of children aged up to one year, with relatively fresh memories of the prenatal period, two waiting for the birth of a child, including one expecting a subsequent child, two men who are not fathers and not waiting for the birth of a child at the time of the examination, and two men who were certified psychologists (one of whom was a child therapist and who had a child). The team performed a content analysis of each item to determine whether they accurately described the father-child prenatal bond. The judges agreed that items 2 (*"I plan the things I will do with my baby"*), 12 (*"I feel love for the baby"*), and 21 (*"I am happy, when my wife/partner et me put my hands on her tummy to feel the baby move"*) are good indicators of the paternal prenatal bond, and that the items 1 (*"I dream about the baby"*), 6 (*"I share secrets with the baby"*), 9 (*"I can make my baby move"*), 17 (*"I think that my baby already is a person"*), and 20 (*"I tell others what the baby does inside my wife's/partner's tummy"*) did not adequately describe the paternal prenatal bond. The judg-

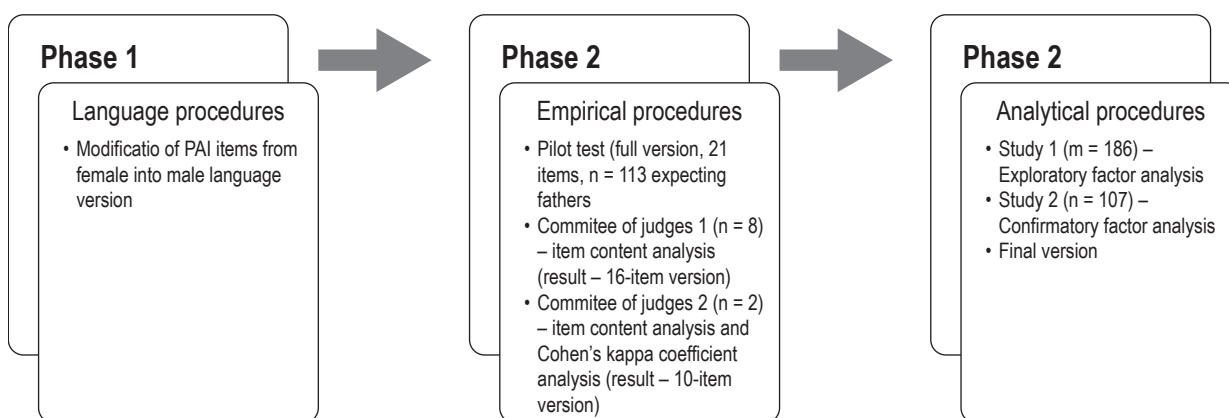


Figure 1. Phases corresponding to the development and validation of the male version of the Prenatal Assessment Inventory.

es argued, for example, that “*Telling others what the baby is doing inside the wife’s/partner’s tummy*” (item 20) not only does not indicate an emotional connection, but it is revealing intimate details that should remain an experience only between future parents. On this basis, items No. 1, 6, 9, 17, and 20 were removed.

As the content of the remaining statements raised doubts among the judges, two additional judges were appointed: one psychologist, an academic lecturer experienced in psychometry, and one man expecting his first child. They assessed each of the remaining 16 items in terms of accuracy in describing the prenatal bond, as *completely inaccurate* (rate 1), *I have no opinion* (rate 2), and *very accurately* (rate 3). Cohen’s Kappa coefficient was 0.724, which according to the guidelines indicates a good agreement [19]. Items 4, 5, 7, 8, 11, and 15 that were judged as not to be relevant have been removed.

Phase 3 consisted of two studies. Firstly, factor analysis was performed to determine the factor structure of the 10-item version of the PAI for men, created in the previous stages (Study 1). The analysis was performed because the current, shorter version of PAI was in fact a new tool. For this purpose, 186 men expecting their first

child were examined (see: Table 1). The model was then subjected to CFA to confirm its degree of fit; data was obtained from 107 men expecting their first child (see: Table 1) and confirmatory factor analysis was performed. The detailed results of the abovementioned analysis are presented in the *Results* section.

Data Collection

At all stages, recruitment took place at pregnancy classes and at gynecological offices where expectant fathers accompanied their partners. Upon contacting a potential participant, a research assistant would explain the aims and procedures of the study and inform the fathers that the results would only be used for scientific purposes, that participation is voluntary and anonymous, and that they could withdraw at any time. Those who agreed to participate signed an informed consent form and received a set of paper questionnaires to complete. The fathers could complete the questionnaire on the spot and immediately return it to the research assistant or take it with them and return it at the next med-

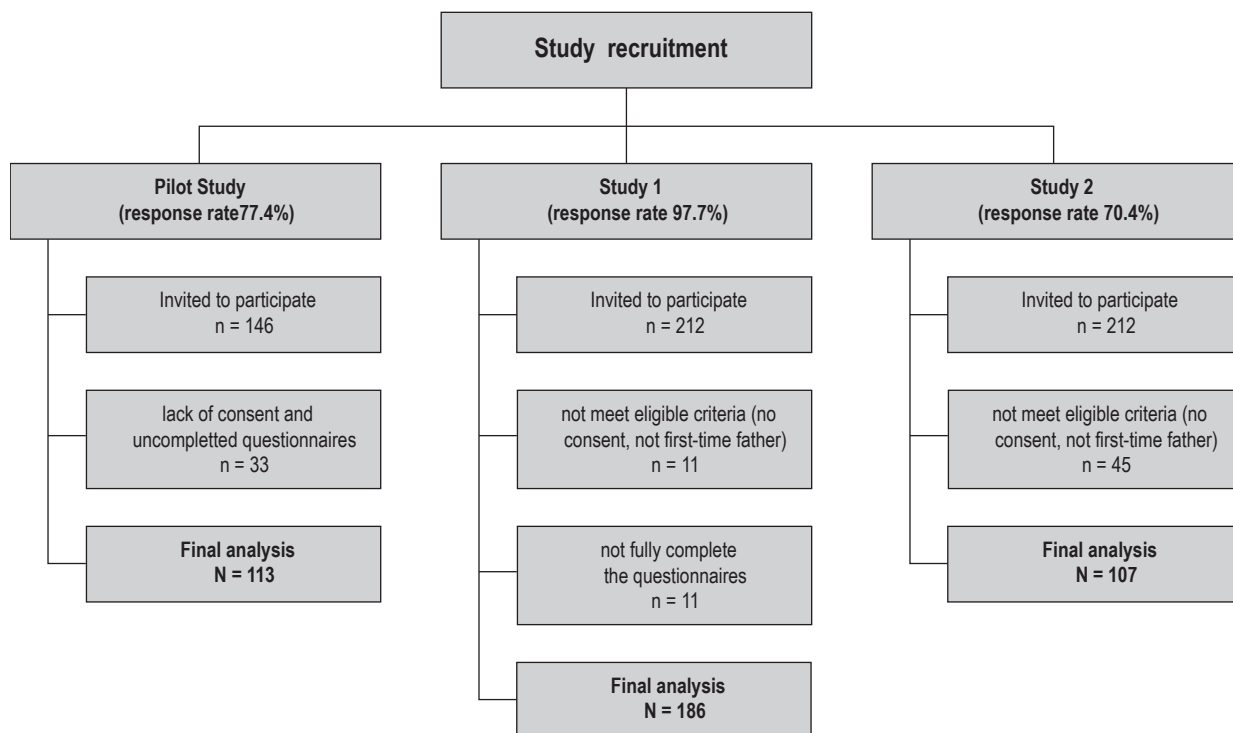


Figure 2. Flow diagram of recruitment of the studies population

ical visit, or at a time and place agreed with the assistant.

The data were collected from February 2018 to December 2019. In the pilot study, 113 (77.4%) of the 146 participants meeting the inclusion criteria agreed to participate, and fully completed the questionnaires. In Study 1, and Study 2, a total of 186 and 107 first-time expectant fathers who met the eligibility criteria were included in the analyses, respectively. The detailed information about the recruitment process is presented in Figure 2.

Participants

Pilot study

The pilot study included 113 new expectant fathers aged 23 to 49 ($M=30.6$; $SD=4.8$). Most of the respondents were married (76.1%), lived in a large city (55.8%), and had a university degree (70.8%). A detailed description of the pilot sample can be found in Table 1. The collected data were used only to verify whether they fitted to the original one-factor and five-factor [16] structures of the PAI for women.

Study 1

The first study sample included men aged 22 to 51 ($M=30.5$; $SD=4.9$). Of the 212 who volunteered to participate, 186 (response rate: 87.7%) met the eligibility criteria and completed the set

of questionnaires. Most of the participants were married (75.8%) lived in a large city (54.8%) and had a university degree (67.7%). The gender ratio of the expected children was 58.6% vs 38.2%, for boys and girls, respectively. A total of 89.2% of expectant fathers declared that the current pregnancy was planned, and without any risk (82.8%), and that they did not have previous fertility problems (93.5%). The results obtained in this study were used only to check the discriminatory power of the tool and the factor structure of the new Polish language version of the PAI for men (Table 1).

Study 2

Of the 152 expectant fathers who responded to recruitment for Study 2, 107 fulfilled the eligibility criteria and returned completed questionnaires (response rate: 70.4%). The participants were 22 to 43 years old ($M=30.3$; $SD=4.3$). Similarly, the majority of the respondents were married (75.7%) lived in a large city (54.2%) and had a university degree (68.2%). The gender ratio of the expected children was similar (46.7% vs 47.7%, for boys and girls, respectively). In most cases, the current pregnancy was planned (85.0%), without any risk (81.3%), and without previous fertility problems (93.5%). The results obtained in Study 2 were used to confirm the factor structure of the final 10-item version of the PAI for men (Table 1).

Table 1. Characteristics of the Pilot study ($N=113$), Study 1 ($N = 186$), and Study 2 ($N = 107$) population

		Pilot study sample ($N=113$)		Study 1 ($N=186$)		Study 2 ($N=107$)	
Age		$M=30.6$; $SD=4.8$ (min.23; max.49)		$M=30.8$; $SD=4.7$ (min. 22, max.51)		$M=30.3$; $SD=4.3$ (min.22, max.43)	
		<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Marital status							
	Married	86	76.1	141	75.8	81	75.7
	Informal relationship	27	23.9	45	24.2	26	24.3
Length of the relationship (years)		$M=5.6$; $SD=3.5$ (min. 1; max.18)		$M=5.7$; $SD=3.5$ (min.1, max.20)		$M=5.4$; $SD=3.6$ (min.1, max.13)	
Education level							
	Primary	9	8.0	20	10.8	9	8.4
	Secondary	24	21.2	40	21.5	25	23.4

	University degree	80	70.8	126	67.7	73	68.2
Place of residence							
	Large city	63	55.8	102	54.8	58	54.2
	Small/middle-size city	28	24.8	46	24.7	29	27.1
	Village	22	19.5	38	20.4	20	18.7
Gestational week		<i>M</i> =33.3; <i>SD</i> =3.2 (min.28, max.40)		<i>M</i> =33.4; <i>SD</i> =3.1 (min.28, max.41)		<i>M</i> =33.2; <i>SD</i> =3.2 (min.28, max.40)	
Planned pregnancy							
	Yes	96	85.0	166	89.2	91	85.0
	No	17	15.0	20	10.8	16	15.0
Infant gender							
	Male	52	46.0	109	58.6	50	46.7
	Female	54	47.8	71	38.2	51	47.7
	Unknown	7	6.2	6	3.2	6	5.6
Pregnancy risk							
	Yes	20	17.7	32	17.2	20	18.7
	No	93	82.3	154	82.8	87	81.3
Fertility problems							
	Yes	7	6.2	12	6.5	7	6.5
	No	106	93.8	174	93.5	100	93.5

Data analysis

The data were analyzed using the Statistical Package for the Social Sciences (SPSS) version 27, and structural equation modeling (SEM) was performed using AMOS SPSS version 26.

Demographic characteristics were summarised as the mean (*M*) with standard deviation (*SD*) for continuous variables, and as frequency counts (percentages) for categorical variables. The exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were performed using two different sample groups, as recommended for scale adaptation studies [20].

In Study 1, to confirm that it was suitable for factor analysis (FA), the data was assessed with Bartlett's Test of Sphericity, with results $p \leq .05$ begin considered significant [21] and the Kaiser–Meyer–Olkin Measure of Sampling Adequacy (KMO), whose loading is suggested as above .60 [22]. The number of retained components was guided by Kaiser's criterion (eigenvalues >1), parallel analysis, and Catell's scree test [23] with inspection of the scree plot. Initially, all

components with eigenvalue >1 and statements loading above 0.50 were retained.

In Study 2, to confirm the structural validity of the male version of the PAI, confirmatory factor analysis (CFA) was performed using the maximum likelihood method. The validity of the model was evaluated based on a combination of data–model fit statistics in conjunction with various other parameter estimates and factor loadings [24]. Goodness of data, i.e. model fit, was confirmed using a combination of absolute, parsimonious, and incremental fit indices. Tucker–Lewis Index (TLI) and comparative fit index (CFI) values between .90 and .95 and root mean square error of approximation (RMSEA) values (with a 90% confidence interval) between 0.05 and 0.08 were interpreted as indicating adequate data–model fit, while TLI and CFI values > 0.95 and RMSEA values < 0.05 were considered indicative of good data–model fit [25]. The Normed Fit Index (NFI) was calculated, defined as 1 minus the χ^2 value of the proposed model divided by the χ^2 values of the null model. The NFI results range from 0 to 1, with higher

values indicating a better fit. NFI values above 0.9 usually represent acceptable fit. Factor loading values higher than 0.50 were considered to be strong. Internal consistency was calculated using the standardized Cronbach's alpha coefficient (α), which was considered adequate when $\alpha \geq 0.70$ [26]. However, as the latent construct reliability was established, coefficients (H) ≥ 0.70 were considered desirable [24]. In the following analyses, the criterion $p < 0.05$ was used to determine whether the results were statistically significant.

RESULTS

Pilot Study

Confirmatory Factor Analysis

The results of the confirmatory factor analysis (CFA) using the maximum likelihood method did not find any adequate fits in the original one-factor (Model 1) or five-factor (Model 2) solution (16) for male version of the PAI. As can be seen in Table 2, CFAs indicated that both one- and five-factor models were a poor fit.

Table 2. Goodness-of-Fit Indicators of one-, and five-factor models (Pilot Study; $N = 113$)

Model	Structure	χ^2	df	χ^2/df	CFI	TLI	NFI	RMSEA [90% CI]
Model 1 (original PAI, 21-item version for women)	1-factor	665.82	208	4.56	0.22	0.22	0.16	0.27 [0.25; 0.30]
Model 2 (proposed by Bielawska-Batorowicz & Siddiqui, 2008)	5-factor	582.01	130	4.48	0.61	0.59	0.55	0.16 [0.14; 0.17]

Note. χ^2 – Chi-squared test; df – degrees of freedom; CFI – Comparative Fit Index; TLI – Tucker–Lewis Index; NFI – Normed Fit Index; RMSEA – Root Mean Square Error of Approximation; CI – confidence interval; $p < 0.001$

Study 1

Descriptive Statistics and Exploratory Factor Analysis

This study analyzed the 10-item version established by the panel of competent judges. The mean value for the 10-item PAI score was found to be 31.75 with a standard deviation of 5.18. The correlation observed between the majority of items with the overall scale exceeded the recommended threshold of 0.30 (ranging from 0.37 to 0.70). To examine the structure of this version of the PAI, a principal components (PC) factoring with varimax rotation was conducted. The satisfactory value of KMO of 0.838 was observed [27]. Bartlett's Sphericity test [$\chi^2(45) = 745.82$; $p < 0.001$] proved to be statistically significant, which is also an indicator that the data was adequate for performing the factor analysis. The analysis revealed three components with eigenvalues larger than 1 (Kaiser's criterion), cumulatively explaining more than 67% of the variance. The scree plot is also indicative of a three-factor solution (Fig.3)

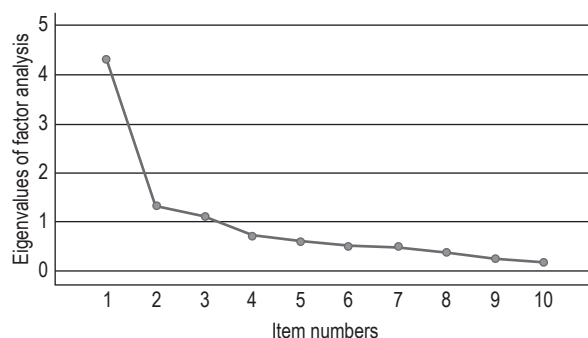


Figure 3. The scree plot of the EFA of the PAI items ($N = 186$)

The PAI-M consisted of 10 statements. Based on the content analysis and the interpretation of these items, the following three subscales were identified: *Feelings for the child and feelings related to the child* (Factor 1), *Thoughts and beliefs about the child* (Factor 2), and *Interactions and activities for the child* (Factor 3). In addition to the subscale scores, which can be used as standalone measures, the total score from all statements was summed to create a general paternal prenatal attachment composite measure. The subscale representing feelings for the child and related to

the child (called *Feelings*) contained four statements; these were with the feelings that the future father experiences when thinking about the child, or regarding the physical contact with the child in the mother's womb. The Thoughts and beliefs about the child subscale (called *Thoughts and beliefs*) contained three statements pertaining to thoughts and ideas about the baby's activity in the mother's womb. The Interactions and activities for the child subscale (called *Interactions and activities*) contained three statements that related to preparing for the birth of the child and to interacting with the child. In each of the three

subscales, as well as in the total scores, a higher score indicated a stronger level of prenatal attachment.

The first factor had an eigenvalue of 4.30 (variance explained 43.04%), the second 1.32 (variance explained 13.17%) and the third 1.14 (variance explained 11.44%). These three factors explained 67.65% of the total variance. The newly formed 10-item tool will be referred to later in this article as PAI-M (Prenatal Attachment Inventory – male version). Table 3 presents the factor loadings for this solution.

Table 3. PAI-M items and factor loadings for the three-factor solution (Study 1; N = 186)

Item No.	Statement	Factor 1 (F1)	Factor 2 (F2)	Factor 3 (F3)
PAI_21	I am happy, when my wife/partner let me put my hands on her tummy to feel the baby move <i>Cieszę się, kiedy moja żona/partnerka pozwala mi kłaść ręce na swoim brzuchu, żebym mógł poczuć jak dziecko się porusza</i>	0.91		
PAI_13	I enjoy feeling the baby move <i>Odczuwanie ruchów dziecka sprawia mi przyjemność</i>	0.86		
PAI_14	I like to sit with my arms around my wife's / partner's tummy <i>Lubię oplatać rękami brzuch mojej żony/partnerki</i>	0.82		
PAI_12	I feel love for the baby <i>Czuję miłość do dziecka</i>	0.63		
PAI_3	I wonder what the baby look like now <i>Zastanawiam się, jak teraz wygląda moje dziecko</i>		0.78	
PAI_10	I try to imagine what the baby is doing inside the tummy <i>Próbuję wyobrazić sobie, co dziecko robi wewnątrz brzucha</i>		0.77	
PAI_16	I know the baby hears me <i>Wiem, że dziecko mnie słyszy</i>		0.69	
PAI_18	I imagine calling baby by name <i>Wyobrażam sobie, jak zwracam się do dziecka po imieniu</i>			0.81
PAI_19	I buy/make things for the baby <i>Kupuję/robię rzeczy dla dziecka</i>			0.80
PAI_2	I plan the things I will do with my baby <i>Planuję, co będę robić razem z moim dzieckiem</i>			0.55

Note. The number of statements derived from the original version of the PAI (Muller, 1989).

Study 2

Confirmatory Factor Analysis and Internal Consistency

To determine whether the new three-factor model would fit the PAI-M data ($N = 107$), confirmatory factor analysis (CFA) using the maximum likelihood method was employed. The CFA organized the 10 items in the Polish version of the

PAI-M as indicators of three fully-correlated second-order latent factors (F1, F2, and F3); the results indicated an adequate data-model fit (CFI = 0.93, TLI = 0.91, NFI = 0.86, RMSEA = 0.08, 90% CI [0.06, 0.12]). The model was characterized by robust factor loadings for each latent construct, with beta coefficients ranging from 0.56 to 0.94, and R^2 coefficients ranging from 0.31 to 0.88, $p < 0.001$ (see Tab. 4).

Table 4. The Results of Confirmatory Factor Analysis of PAI-M

Factors	Item No.	R^2	β	B	SE	CR
Factor 1	12	0.75	0.87	1.00		
	13	0.88	0.94	1.64	0.09	17.94 ***
	14	0.66	0.81	1.86	0.11	17.67 ***
	21	0.74	0.86	1.76	0.09	17.67 ***
Factor 2	3	0.44	0.67	1.00		
	10	0.31	0.56	2.43	0.09	25.95***
	16	0.37	0.61	1.68	0.09	19.57***
Factor 3	2	0.58	0.76	1.00		
	18	0.33	0.58	1.91	0.09	19.79 ***
	19	0.40	0.63	2.13	0.09	23.99 ***

Note. R^2 – determination coefficient; β – standardized regression coefficient; B – non-standardized regression coefficient; SE – non-standardized regression coefficients error; CR – critical ratio; *** indicates $p < 0.001$.

Pearson's correlation coefficients between all factors were statistically significant ($p < 0.001$). As expected, the correlations between factors confirmed the validity of the tool: fathers who reported a higher score for one aspect of prenatal attachment also demonstrated a higher score for the others. However, the strongest relationship was found between *Thoughts and beliefs* and *Interactions and activities* (F2 vs F3; $r = 0.55$). Regarding the other analyses, Pearson's r values were found to be 0.42 for *Feelings* and *Thoughts and beliefs* (F1 vs F2), and 0.39 for *Feelings* and *Interactions and activities* (F1 vs F3).

Adequate-to-strong latent construct reliabilities were also established for Factor 1 ($\alpha = 0.91$; $H = 0.94$) and Factor 3 ($\alpha = 0.71$; $H = 0.71$), and for the higher-order factor of attachment, which was the total score ($\alpha = 0.87$; $H = 0.95$). Only Factor 2 obtained internal consistency coefficients slightly lower than the recommended 0.70 ($\alpha = 0.64$; $H = 0.67$). However, Factor 2 consists only three items and the as the internal consistency coefficients are sensitive to the number of items, ob-

tained values seems to be acceptable. Additionally, as the total score demonstrated high internal consistency and removing any of the items from Factor 3 did not increase reliability, at this stage it was decided to keep the PAI-M in its current version (see Fig. 4).

DISCUSSION

The present study aimed to establish the factor structure of the Prenatal Attachment Inventory (PAI) among Polish first-time expectant fathers and evaluate its psychometric properties. The results confirm that this male version of the inventory, the PAI-M, has a three-factor structure; however, this contrasts with the one – and five-factor solutions tested and proposed in previous studies [16, 5]. It is significant that when developing a language version adequate for fathers, differences resulting from the male point of view emerged even at the content analysis stage.

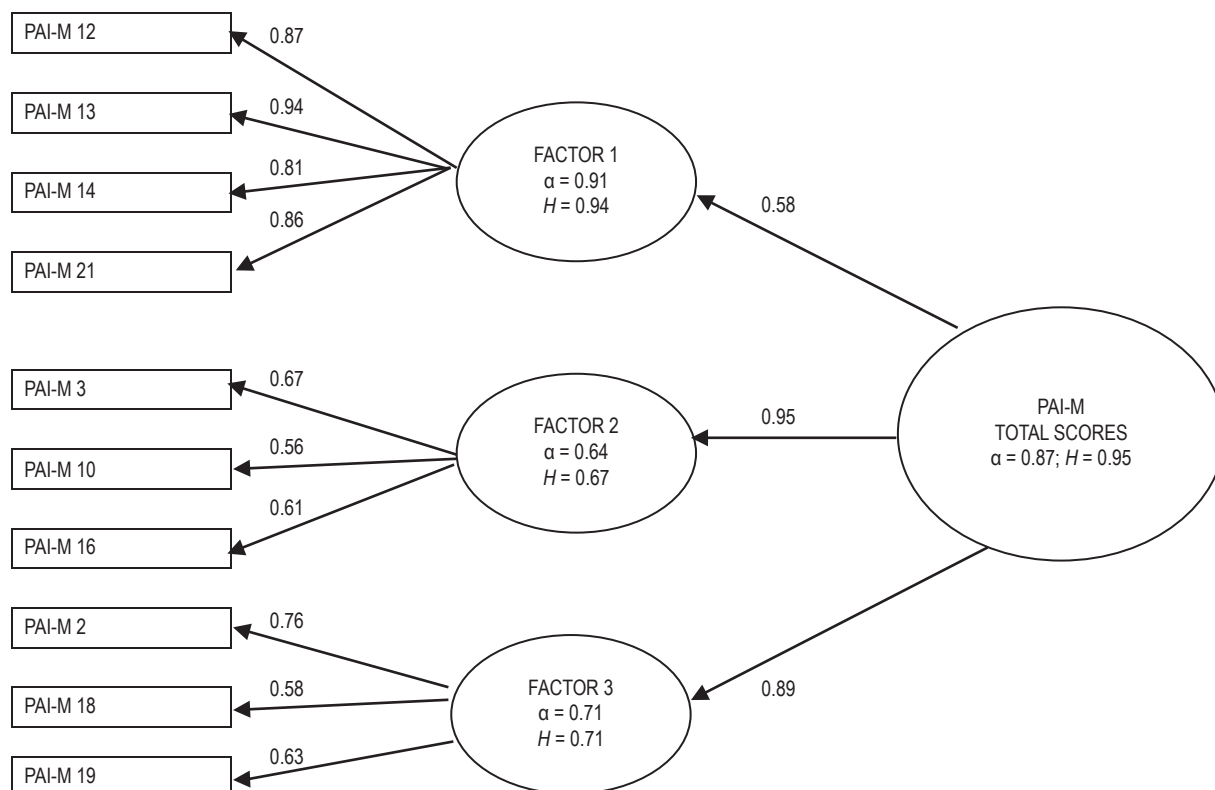


Figure 4. CFA of the structural model of the PAI-M (Study 2; N=107)

For example, the panel of competent judges excluded most of the items that make up the *Fantasy* factor and all items that make up the *Interaction* factor from the previous five-factor model [16]. They also considered all the statements constituting the *Affection* factor in this model as adequately describing paternal prenatal attachment.

This suggests that from a fathers' perspective, prenatal attachment is mainly manifested through emotions such as joy, happiness or love. This is reflected in the obtained psychometric values and the resulting factor structure of the PAI-M, which was confirmed in subsequent analyses. In the current study, factor 1 – *Feelings*, explains the highest percentage of variance and has the highest Cronbach's alpha score; it also includes many of the items from the *Affection* subscale in the previous five-factor version.

In the current study, fathers were found to be less likely to manifest attachment by sharing information about how active the baby is in the womb, and probably found it more difficult to attribute traits to the baby during this period (i.e. like in a statement "I think that my baby already is a person"). Similarly, a meta-analysis of 205 studies found that men were less likely to engage in

self-disclosure, i.e. the general sharing of personal details about one's life, feelings, thoughts, memories and other private information, than women [28]. According to Seamon [29] women are more likely to talk about intimate or personal topics with each other, while men have a greater need to control their privacy [30]. This lower level of self-disclosure when experiencing the expectation of a baby may well have been the reason for the removal of such items as "Telling others what the baby is doing inside the wife's / partner's tummy" from the final version of the questionnaire. And finally, indeed, none of the statements about sharing information about the child with others was included in the PAI version selected as a result of the current study. Such a result seems to confirm and emphasize that the mode of experiencing pregnancy and forming an attachment to an unborn child differs between men and women. In developing the Prenatal Attachment Inventory, Muller [5] emphasized that the tool measures "the unique, affectionate relationship that develops between a woman and her fetus" [5, p. 201] and focuses on affiliation, rather than on the behaviors. These assumptions appear to be maintained in the structure

and content of the items for the new version for fathers (PAI-M).

The possibility that paternal prenatal attachment is expressed differently from maternal attachment seems to be supported by the weaker internal consistency of the second factor, *Thoughts and beliefs*. The statements included in this factor pertain to thoughts and ideas about the baby's activity in the womb. It seems understandable that men expecting a baby have greater difficulty in visualizing the fetal manifestations of a child because they are not pregnant themselves. Indeed, previous research has found expectant fathers to have lower fetal attachment scores than expectant mothers [31]; as such, it is important to recognize factors that influence paternal prenatal attachment. Since prenatal attachment is negatively associated with postpartum bonding disorders [32, 33, 34] understanding the specific aspects of the relationship between a future father and his child at the prenatal stage can not only clarify the process of paternal prenatal attachment formation, but also help support fathers through the prenatal period.

Study limitations

While the Polish version of the PAI-M demonstrates good overall psychometric values, this study has some limitations that should be taken into consideration. First, as all participants were volunteers, only relatively small groups could be formed at each phase of the study; indeed, similar difficulties in recruiting fathers of children of any age to participate in research have been noted in previous studies [*cf.* 35, 36,; 37]. Yaremych and Persk [38] propose that the recruitment procedure used for fathers has a significant influence on sample size, response rate and retention of participants. Although, in this era of technological development, previous authors have extolled the virtues of online recruitment and research [39, 40] the present study used face-to-face recruitment and paper-and-pencil surveys to increase the chance of obtaining reliable and complete questionnaires. Additionally, it also provided all expectant fathers the opportunity to talk to the researcher and raise any doubts accompanying them in the process of adapting to paternity.

Second, the majority of participants were well-educated, married men, living in large urban areas, which could call into question the generalizability of the findings. The method and place of recruitment are also important for the results of the current study. Recruiting expectant fathers at pregnancy classes and gynecological offices makes the surveyed population not representative. Future fathers who i.e. attend pregnancy classes with their partners may show greater commitment and a higher level of prenatal bonding. The results should therefore be interpreted with caution and accompanying or not the child's mother during medical visit is certainly a factor that should be considered in further studies of paternal prenatal bond.

To further validate the psychometric properties and factor structure of the PAI-M, future studies should aim to recruit more diverse groups of participants, including general samples of varying sociodemographic backgrounds, together with fathers with non-physiological pregnancies, such as those experiencing serious fertility difficulties, those who had lost a previous child or perhaps those with a high-risk pregnancy (including lethal defects of the fetus).

Third, in the current study, all fathers were examined during the third trimester (from 28 to 40 gestational week), therefore, it was not possible to determine whether the strength of attachment differs depending on the stage of pregnancy. Muller [5] reports a positive correlation between the PAI score and gestational week, and da Rosa et al. [41] indicate lower levels of attachment (measured by the Maternal-Fetal Attachment Scale; MFAS) among women with lower gestational age. It can be assumed that similar relationships will occur in men, especially since the process of shaping prenatal attachment may be more difficult in expectant fathers because they do not experience direct contact with the fetus.

Fourth, as only one self-report measure was used to evaluate factor structure, a repeat study is recommended to determine the validity of the PAI-M. For this purpose, it is worth checking, for example, the relationship between the bond and attitudes towards fatherhood, stress or depression. In addition, it is worth looking at whether differences in the general level of attachment or of the three identified dimensions can be found between risk groups, e.g. when pregnancy is

at risk. Research by Bielawska-Batorowicz and Siddiqui [16] shows that women with high-risk pregnancies had lower total scores of attachment measured by PAI. Thus, it is possible that in case of pregnancy complications women may avoid bonding for fear of losing a baby and suffering even more. It is worth confirming whether similar dependencies can be found in expectant fathers. Such further explorations should include structured diagnostic interviews aimed at assessing any bonding difficulties.

Finally, further work on the reliability and usefulness of the PAI-M as a tool to assess the prenatal bond between father and future child should also include measurement of criterion validity. A recent study on the parental prenatal bond allows to expect that the bond between the father and the prenatal child will positively correlate with the perception of closeness with the child and couple relationship satisfaction [42].

CONCLUSIONS

The male version of the Prenatal Attachment Inventory (PAI-M) has good psychometric properties and is a reliable and valid tool. Although more research is needed to strengthen its validation, current findings suggest that this new version of the PAI is a reasonably comprehensive instrument for assessing the prenatal thoughts, feelings, attitudes, or behaviours towards the fetus among expectant fathers.

The PAI-M can be a useful tool not only for researchers, but also for providing counseling and psychotherapy for future parents, for example, by supporting men in adapting to fatherhood and building a bond with the unborn child during the prenatal stage.

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