The labor curve of the grand multipara: Does progress of labor continue to improve with additional childbearing?

Edith D. Gurewitsch, MD,[a,b] Paul Diament, PhD,[d] Jill Fong, MD,[e] Guan-hua Huang, PhD,[f] Aron Popovtzer, MD,[c] Daniel Weinstein, MD, PhD,[c] and Frank A. Chervenak, MD[b]

New York, NY, Jerusalem, Israel, and Baltimore, Md

OBJECTIVE: Our purpose was to test the hypothesis that progress of labor slows as parity exceeds 4 by comparing labor curves of grand multiparous women (para 5 and over) (GMs) with those of nulliparous and lower-parity multiparous women.

STUDY DESIGN: Retrospective cohorts of spontaneously laboring, vertex-presenting, term GMs who were admitted to two medical centers during the period from January 1990 through June 1995 were randomly computer-matched to a nulliparous and a lower-parity multiparous control subject, matched for age, hospital, and year of delivery. Cervical examination data were graphed retrospectively from the time of full dilatation. Curves were compared by pairwise likelihood ratio tests, by using a random effects model to adjust for obstetric interventions, with significance set at $P < .05$.

RESULTS: Pregnancies in 1095 GMs, 1174 lower-parity multiparous women, and 908 nulliparous women were studied. GMs exhibit a longer initial phase of labor than either nulliparous women or lower-parity multiparous women, begin to dilate rapidly at a greater dilatation than nulliparous women, and experience acceleration of labor at a rate no faster than lower-parity multiparous women. The average labor curve of GMs resembles that of nulliparous women before dilatation of 4 cm is attained, then transitions to the typical curve of the lower-parity multiparous women until dilatation of 6 cm is attained and thereafter is indistinguishable from that of the lower-parity multiparous women ($P < .001$).

CONCLUSIONS: Once parity exceeds 4, progress of labor slows. “Poor progress” beyond dilatation of 4 cm should not be considered abnormal for a GM, because she is likely still in the latent phase until dilatation of 6 cm is attained. Nor should she be expected to progress through her active phase any faster than lower-parity multiparous women. (Am J Obstet Gynecol 2002;186:1331-8.)

Key words: Grand multiparity, labor curves, cervical dilatation, labor progress

Physiologic effects of increasing parity have been described in both the cervix and the uterus. During the last weeks before the onset of labor, the parous cervix is less effaced but more dilated than the nulliparous cervix.[1,2] During labor, the parous uterus requires less activity to effect a normal delivery than a nulliparous uterus, owing to less uterocervical resistance and increased uterine efficiency.[3,4] This is consistent with Emanuel Friedman’s seminal work demonstrating an increased rate of cervical dilatation in multiparous compared with nulliparous women.[5]

However, it is not necessarily true that the advantages of prior deliveries continue to accrue indefinitely with additional childbearing. Pathologic changes occur in the uterus with advanced parity, which appear to be inconsistent with improved labor efficiency. Nelson and Sandmeyer[6] examined hysterectomy specimens from women of high parity (para 8 or over) and described a fragile, poorly elastic uterine wall with sparsely spaced myometrial fibers and increased hyalinization and fibrosis.

The effects of such changes, which seem more likely to impede the progress of labor than to enhance it, are not evident in studies that compare labor in nulliparous women with labor in multiparous women. However, in most studies, the parity of the multiparas was either not particularly high,[3] or else only a few grand multiparas (GMs) were evaluated.[5] Although in Friedman’s original 1956 article[5] describing labor in 300 multiparous women only 19 women had parity of 5 or over, when he grouped his patients by parity he noted 2 trends. First, the latent phase appeared to shorten with each successive pregnancy until the fourth, and thereafter it lengthened. Sec-

From the Departments of Obstetrics and Gynecology of the Johns Hopkins University School of Medicine,[a] New York Presbyterian Hospital–Weill Cornell Medical Center,[b] Hadassah-Hebrew University Medical Center,[c] Department of Electrical Engineering, Columbia University,[d] Department of Anesthesiology, New York Presbyterian Hospital–Weill Cornell Medical Center, and Department of Biostatistics, The Johns Hopkins University School of Public Health and Hygiene.[f]
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Reprint requests: Edith D. Gurewitsch, MD, Assistant Professor of Gynecology and Obstetrics, Division of Maternal Fetal Medicine, Department of Gynecology and Obstetrics, The Johns Hopkins Hospital, 600 North Wolfe St, Phipps 217, Baltimore, MD 21287.

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ond, the duration of the active phase remained remarkably stable with increasing parity, despite an increase in the mean maximum slope and decrease in the duration of the deceleration phase.[5]

In the English-language medical literature, only 2 studies have specifically graphed labor curves of GMs. In 1986, Petrikovsky et al[7] analyzed cervical dilatation data from the medical records of 500 GMs (para 5 or over), which they least-square–fitted to a computer-generated, preselected model. They then compared the labor curve they obtained with Friedman's sigmoid curve and argued that grand multiparous labor was better described by "two intercepting exponential linear curves" than by a single sigmoid curve.[7] However, although their methodology was entirely different from Friedman's, Petrikovsky et al did not test their own model against nulliparous or lower-parity multiparous control subjects. Consequently, the question of whether their best-fit family of curves might have applied just as well to the less parous women remains. Furthermore, the inclusion criteria in the 2 studies differed markedly. Although Friedman included patients with operative deliveries, augmented labor, and poor outcomes, Petrikovsky et al excluded these. And, because they used inclusion criteria that could be determined only retrospectively, it is difficult to apply the results obtained by Petrikovsky et al to the usual prospective clinical setting.

The second study of labor curves in GMs was a 1994 Finnish study by Juntunen and Kirkinen.[8] They concluded that there was no difference in the labor curves of any parity group, not even between multiparous and nulliparous groups. This study was prospective, with a methodology similar to Friedman's and with control groups of nulliparas and lower-parity multiparas. Patients given regional anesthesia and amniotomy were included, but not those with augmented labors or operative deliveries. Unfortunately, the use of amniotomy and epidural anesthesia varied markedly between the parity groups, which had only 42 women each. With so small a sample size and no adjustment for obstetric intervention, this study lacked the power to support its conclusions.

The objective of the present study was to determine the effect of grand multiparity on the rate of cervical dilatation during labor and to compare the labor curves of GMs with those of nulliparas and lower-parity multiparas. We hypothesized that once parity exceeds 4, progress of labor slackens and that the labor curve of GMs is distinct from that of nulliparas and of lower-parity multiparas.

Methods

Study population. After approval had been obtained from the institutional review boards, cohorts of all GMs (para 5 and over) admitted to labor and delivery departments at the New York Presbyterian Hospital–Weill Cornell Medical Center in New York City and the Hadassah–Hebrew University Medical Center in Jerusalem between January 1, 1990, and June 30, 1995, were identified from the delivery records at each institution. Only the following data, identifiable on admission, were used as inclusion criteria to preserve a cohort design. Subjects were required to be between 36 and 43 estimated weeks of gestation and to have been admitted in spontaneous labor, with an uncomplicated, singleton pregnancy in vertex presentation. Birth weight, mode of delivery, Apgar scores, number of cervical examinations performed during labor, and the intrapartum use of analgesia, amniotomy, or oxytocin augmentation (all of which could not have been known prospectively) were not used as a basis for inclusion or exclusion from the study. However, such data were recorded and analyzed. Women whose labor curves could not be assessed, such as those with contraindications to labor or who were delivered before reaching the hospital, were not included. Women with prior uterine scars or hydramnios were excluded to avoid the question of "functional parity" among patients with prior cesarean deliveries or "predetermined uterine dysfunction," possibly caused by prior myometrial incisions or by uterine overdistention. Similarly, on the presumption that normal labor involves an intact maternal-fetal interaction, any patient with an antenatally diagnosed fetal death or major congenital anomaly was also excluded. Because our hypothesis presumes that labor will differ in any given woman depending on how many deliveries she has had, we chose to base our selection of study patients on parity, rather than individual women. Thus, GMs having more than one pregnancy that met inclusion criteria during the study period had each such pregnancy included. However, the repeated use of the same woman in some but not all cases was considered in our choice of statistical method of analysis.

Matched control patients. For each GM, one nullipara and one lower-parity (para 1-4) multipara were selected as control patients from among the remainder of the patients in labor admitted during the same period who met the same inclusion criteria. Women were matched for maternal age (±3 years), date of delivery (±12 months), and medical center. Initially, potential control patients were separated as either nulliparas or lower-parity multiparas and then grouped by the matching criteria for each GM. Subsequently, computer-generated random numbers were used to select which particular patient from these subgroups would serve as the control. For GMs with more than one pregnancy in the study, separate control patients were selected for each pregnancy, matched appropriately for age and year of delivery. In addition, if the same woman were to have more than one of her pregnancies randomly chosen as separate controls for different grand multiparous pregnancies, these controls were retained because this was a random occurrence and consistent with our study of parity rather than patient. However, we verified that no one pregnancy was used more than once as a match, that no one woman had more than one of her pregnancies matched to the same grand multiparous pregnancy, and that no woman's prior pregnancies served as her own controls.

Data collection. Serial cervical examination data were abstracted from the medical records for each pregnancy. Other demographic and obstetric data, including age, gravidity, parity, gestational age, mode of delivery, hospital, obstetric interventions, sex of neonate, birth weight, and Apgar scores were also collected. Every effort was made to retrieve missing information from other sources (eg, newborn charts and delivery logbooks); if conflicting information was obtained, the data were deemed unreliable and not collected. Pregnancies with incomplete data were not eliminated unless the missing information was critical to inclusion or exclusion criteria.

Statistical analysis. A random-effects model was generated with SAS statistical software (SAS Institute, Inc, Cary, NC) to analyze and compare the first-stage labor curves between parity groups. The model we constructed expresses each patient's labor curve as an average curve plus some variations specific to a given pregnancy and to a given individual. This approach, based on standard regression analysis for best fit, adjusts for repeated measures within the same pregnancy and for repeated pregnancies in the same individual.

Labor curves were generated from the data from each pregnancy within the parity groups by dividing the progression of data into several short segments, based on 1-cm dilatation cut points. We considered that women had a variable number of cervical examinations at varying times during a given labor and also had a variable number of pregnancies being analyzed. Thus, the formula for the labor curve used in the statistical analysis was

$$t_{ij} = \beta_{i1}[3 - d_{ij}] + \beta_{i2}[4 - d_{ij}] + \cdots + \beta_{i8}[10 - d_{ij}] + \varepsilon_{ij}\,,$$

where t_{ij} is the time (in hours) of the j-th cervical measurement of the i-th pregnancy; d_{ij} is the corresponding measured cervical dilatation (in centimeters); βs represent the regression analysis coefficients to be estimated for best fit of the curve to the data, and ε_{ij} is the random error. The brackets indicate use of the enclosed value if it is positive but substitution of zero if it is negative; the operation indicated by the brackets ensures that the end of any dilatation segment coincides with the beginning of the next one. The 8 cervical dilatation cut points between segments started at 3 cm and increased by 1 cm, up to the ultimate 10 cm. There was very little information on dilatations less than 3 cm; our choice of 3 cm as the first cut point fully utilizes all such data but subsumes all those points under a single interval from 2 to 3 cm.

For the purpose of adjustment for confounding variables, including maternal age, gravidity, gestational age, sex of neonate, birth weight, hospital, and labor interventions of amniotomy, oxytocin augmentation, and epidural analgesia, a further regression analysis was also carried out with the formula expanded by including in the sum an additional β coefficient for each such variable:

$$t_{ij} = \beta_{i1}[3 - d_{ij}] + \beta_{i2}[4 - d_{ij}] + \cdots + \beta_{i8}[10 - d_{ij}] + \cdots$$
$$\beta_9(\text{Birth Weight})_{ij} + \beta_{10}(\text{Maternal Age})_{ij} + \cdots + \varepsilon_{ij}$$

Because patients were admitted to the hospital in varying stages of labor with varying cervical dilatations, neither the time of admission nor the initial dilatation could reliably be used as a reference point from which to generate the combined labor curve of a given parity group. Rather, the time of attainment of full dilatation was used. Although admittedly imprecise, this reference point was more readily identifiable than the onset of labor. Cervical dilatation data were then graphed against time before full dilatation (–1 hour, –2 hours, and so on). When regression analysis is used to estimate the β values, the formula given above creates the fitted labor curve. (Note: Although labor curves are traditionally drawn as dilatation versus time, we chose to use time as the dependent variable to model the prospective, clinical application in which dilatation is, in fact, the known variable by which we estimate the time it will take until full dilatation is reached.)

For those few women in labor who either underwent cesarean delivery before reaching full dilatation or delivered vaginally but for whom the time of full dilatation was not recorded, we used all the available data from such pregnancies; that is, the early fragment of the fitted labor curve for these cases was included, up to the last recorded data point. However, for those data to be properly placed with respect to the fitted labor curve of all pregnancies within a given parity group, it was necessary to estimate the missing time of full dilatation to serve as the reference point for the curve and allow us to assign relative hours before full dilatation to the cases with interrupted first-stage data. The missing reference time of full dilatation was extrapolated by comparison with similarly parous patients who had a similar cervical dilatation at the time of admission, but only the actual recorded data from the interrupted labor curves were used in the ultimate analysis.

In the end, we restricted our analysis to only those women in labor who had 3 or more first-stage cervical examinations, because an entire labor curve would be under-determined if there were only 1 or 2 data points. A separate analysis of the labors with fewer than 3 data points was made to confirm that the exclusion of these data introduced no significant bias against labor that progressed more rapidly. This analysis compared cervical dilatation on admission between patients included and those excluded and also across parity groups, to verify that the excluded patients were in fact admitted during a

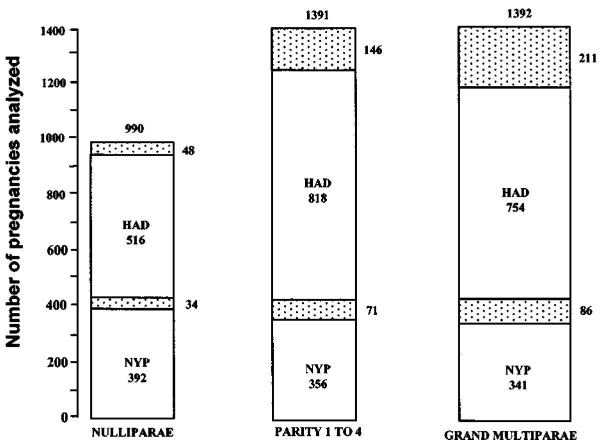

Fig 1. Study population stratified by parity group and hospital. *Shaded areas* represent pregnancies with fewer than 3 cervical examinations, ultimately not included in the analysis. According to generalized estimating equations, differences in proportions of pregnancies with at least 3 cervical examinations were statistically significant between parity groups ($P < .001$). *NYP,* New York-Presbyterian Hospital; *HAD,* Hadassah–Hebrew University Medical Center.

late stage of labor, as opposed to having experienced rapid dilatation from some low value.

Curves for each parity group were created both with and without adjustment for confounding variables and compared by using the likelihood ratio test. Pairwise comparisons were also made to determine whether differences exist specifically between GMs and lower-parity multiparas, between GMs and nulliparas, and between lower-parity multiparas and nulliparas.

Other demographic and obstetric variables were compared among the 3 parity groups, as well as between the 2 hospitals, by using S-PLUS statistical software (StatSci Division, MathSoft, Inc, Seattle, Wash). Because the analysis sometimes involved more than one pregnancy in the same woman, we used generalized estimating equations[9] for both continuous and discrete data, as a substitute for the standard analysis of variance and Student t and χ^2 tests that would have assumed independent data. For all analyses, significance was set at $P < .05$.

Results

Data from a total of 20,710 cervical examinations were collected from 3773 pregnancies. The bar graph in Fig 1 presents the number of patients in each parity group and each hospital. The smaller number of nulliparous matches made at Hadassah was entirely a function of patient age. Although nulliparous women older than 35 years were sufficiently common in New York, not as many such patients could be found in Jerusalem. The median parity of the final study groups was 7 (range, 5-16) among the GMs and 2 (range, 1-4) among the lower-parity multiparas.

Patients who had fewer than 3 first-stage cervical examinations, who were excluded from the analysis, were in fact admitted to the hospital at a significantly more advanced stage of labor than those included in the labor curve analysis. Their mean (±SD) cervical dilatation at admission was 6.27 ± 2.82 cm for nulliparas, 6.59 ± 3.46 cm for lower-parity multiparas, and 6.86 ± 2.42 cm for GMs. These dilatations were not significantly different from each other ($P = .097$) but were significantly different from the mean cervical dilatation at admission (shown in Table I) of the patients who had at least 3 cervical examinations during the first stage of labor ($P < .001$).

Among the 3177 pregnancies in the analysis, there were 2917 individual women, of whom 234 (8.0%) had more than one of their pregnancies included, accounting for 494 (15.6%) pregnancies. Forty-seven women had cesarean delivery after reaching full dilatation, whereas 79 had their cesarean deliveries performed during the first stage of labor. In addition, among the vaginal deliveries (both spontaneous and operative), there were 51 instances for which the time of full dilatation was not recorded in the chart, usually in cases of precipitous delivery.

A comparison of demographic and obstetric variables between the parity groups is given in Table I. These data were also stratified by hospital, and a comparison of the 2 medical centers is given in Table II. There was no significant difference between parity groups with respect to sex of the neonates ($P = .45$). The frequencies of cesarean delivery, amniotomy, oxytocin augmentation, and epidural anesthesia in each parity group, stratified by hospital, are shown in Fig 2.

Our analysis revealed that the curves of each parity group were significantly influenced by birth weight, gestational age, hospital, and the interventions of amniotomy, oxytocin augmentation, and epidural anesthesia ($P < .001$ for each). Maternal age ($P = .6260$), gravidity ($P = .4056$), and sex of the neonate ($P = .9143$) were not significant confounding variables. When the effects of the confounding variables were controlled for, there was still a significant difference ($P < .001$) found in the results of pairwise likelihood ratio tests between the fitted labor curves of the different parity groups. The curves obtained with adjustment for the confounding variables are presented in Fig 3. (Note: Although the statistical analysis was modeled as time versus dilatation, the graphs are presented in the traditional dilatation versus time format for ease of interpretation.)

Characterization of the effects of the confounding variables is the subject of a secondary analysis of this data set and will be presented in a future publication.

Comment

There are several striking features to the average labor curves delineated by our study. In contrast to Petrikovsky

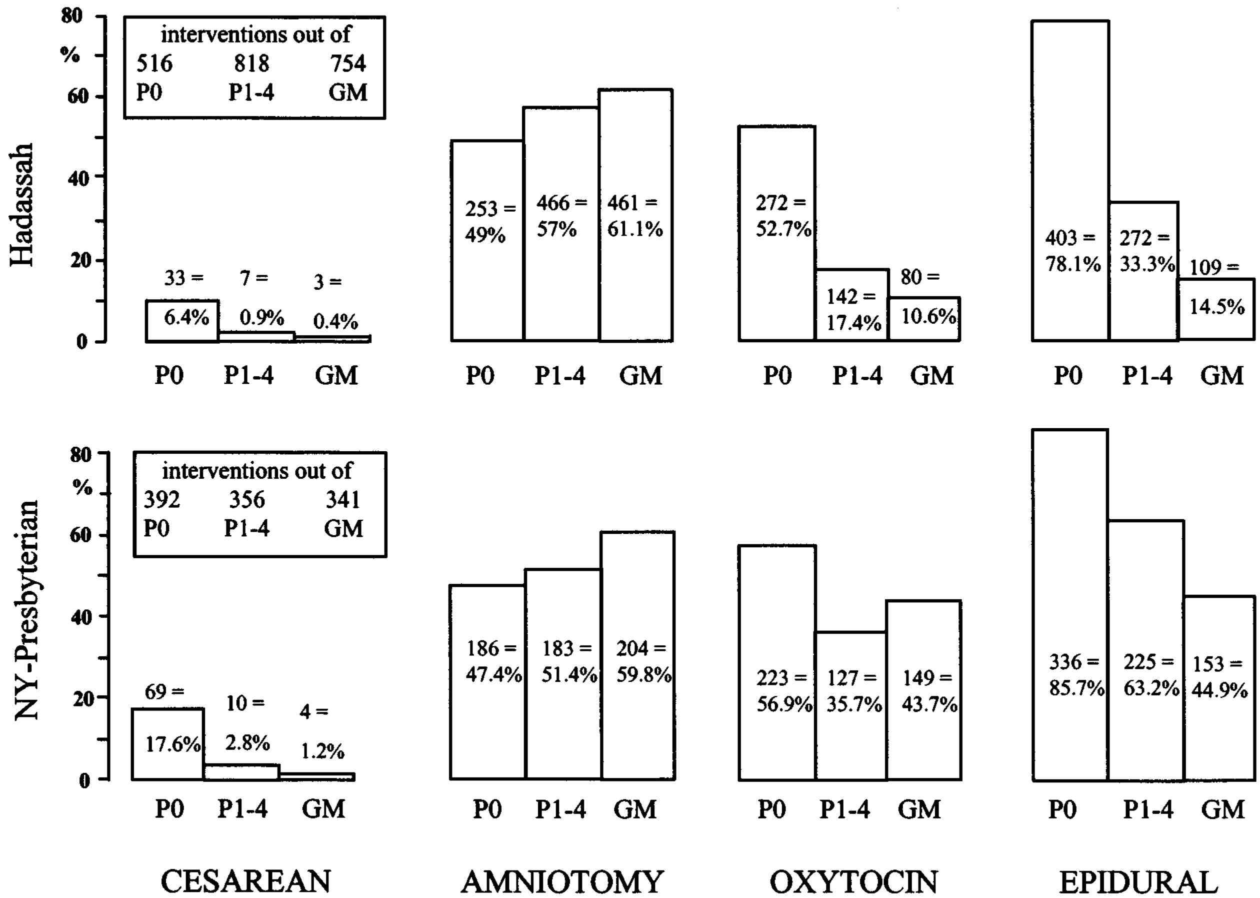

Fig 2. Frequencies of obstetric interventions among parity groups, stratified by hospital. Frequencies of cesarean delivery, amniotomy, oxytocin augmentation, and epidural anesthesia at each hospital are compared between parity groups. According to generalized estimating equations, frequencies of each intervention within each parity group were statistically different between hospitals, except for frequency of cesarean delivery among grand multiparas *(GMs)* ($P = .280$), frequency of oxytocin augmentation among nulliparas *(P0s)* ($P = .236$), and use of amniotomy in all parity groups ($P = .685$, .089, and .729 for P0s, lower-parity multiparas *[P1-4s]*, and GMs, respectively). Differences across the 3 parity groups, whether combined or stratified by medical center, were statistically significant as determined by generalized estimating equations ($P < .001$ for each intervention). When separate pairwise comparisons were made between P0s and P1-4s, P0s and GMs, and P1-4s and GMs, there was no difference between the P1-4s and GMs with respect to the frequency of cesarean delivery (P values for combined sites were .067, .136, and .255, respectively). Although when medical centers were combined there was no difference in frequency of oxytocin augmentation among P1-4s and GMs ($P = .268$), the differences between these groups reached statistical significance when stratified by hospital ($P = .038$ and <.001 for New York Presbyterian Hospital and Hadassah–Hebrew University Medical Center, respectively). Similarly, when stratified by medical center, difference in frequency of amniotomy at NYP between P0s and GMs ($P < .001$) and between P1-4s and GMs ($P = .031$) reached statistical significance, but not between P0s and P1-4s ($P = .280$). At HAD, frequency of amniotomy differed between P0s and P1-4s ($P = .005$) and between P0s and GMs ($P < .001$) but not between P1-4s and GMs ($P = .107$). All other pairwise comparisons remained statistically significant, even when stratified by medical center.

et al[7] and Juntunen and Kirkinen,[8] we have tested our model against nulliparous and lower-parity multiparous control patients and found it to be consistent with the well-known difference between the labor curves of nulliparas and of multiparas; that is, the typical nullipara has a longer latent phase and a less accelerated active phase than the multipara. However, we note that in the progression from nulliparity through low multiparity to grand multiparity, the average labor curve continues to change, but not toward ever-improved progress. The low-parity multipara exhibits an average curve that is clearly distinguishable from that of the nullipara throughout her labor. Notably, we have found that the average labor curve of the GM has a latent phase that is initially the same as that of the nullipara but lasts longer and then joins the curve for the low-parity multipara in its rapid acceleration in the active phase. Labor in the GM follows the rate of dilatation typical of the nullipara until dilata-

Table I. Comparison of demographic and obstetric data among different parity groups

	P0 (*n* = 908)	*P1-4* (*n* = 1174)	*GM* (*n* = 1095)	*P value between parity groups*
Age (y)	33.28 ± 4.29	34.64 ± 4.17	34.71 ± 4.34	<.001
Gestation (wk)	39.81 ± 1.39	40.05 ± 1.41	40.24 ± 1.39	<.001
Birth weight (g)	3263.63 ± 431.25	3402.61 ± 446.33	3493.46 ± 455.80	<.001
Dilatation on admission (cm)	3.07 ± 1.48	3.98 ± 1.45	4.27 ± 1.41	<.001
No. of first-stage exams per patient	5.7 ± 2.3	4.5 ± 1.6	4.7 ± 1.8	<.001

Results are given as mean ± SD; differences between groups were compared by using generalized estimating equations. *P* values in the last column apply to comparisons across all 3 parity groups. When separate pairwise comparisons were made between P0s and P1-4s, P0s and GMs, and P1-4s and GMs, there was no difference in the mean ages of P1-4s and GMs (*P* = .678). Results of pairwise comparisons for all other variables were still statistically significantly different between parity groups. *P0,* Nulliparas; *P1-4,* lower-parity multiparas; *GM,* grand multiparas.

Table II. Comparison of demographic and obstetric data among different parity groups, stratified by hospital

		P0	*P1-4*	*GM*	
	NYP: *HAD:*	*n = 392* *n = 516*	*n = 356* *n = 818*	*n = 341* *n = 754*	*P value between parity groups*
Age (y)	NYP:	35.13 ± 4.37	34.98 ± 4.29	35.01 ± 4.45	.959
	HAD:	31.89 ± 3.66	34.48 ± 4.11	34.55 ± 4.28	<.001
		(*P* < .001)	(*P* = .064)	(*P* = .106)	
Gestation (wk)	NYP:	39.27 ± 1.34	39.24 ± 1.21	39.37 ± 1.30	.282
	HAD:	40.22 ± 1.29	40.40 ± 1.34	40.63 ± 1.24	<.001
		(*P* < .001)	(*P* < .001)	(*P* < .001)	
Birth weight (g)	NYP:	3334.14 ± 440.75	3430.49 ± 448.90	3509.41 ± 454.75	<.001
	HAD:	3209.80 ± 416.33	3390.39 ± 445.00	3486.30 ± 456.39	<.001
		(*P* < .001)	(*P* = .161)	(*P* = .484)	
Cervical dilatation on admission (cm)	NYP:	3.14 ± 1.78	4.16 ± 1.76	4.14 ± 1.63	<.001
	HAD:	3.01 ± 1.20	3.90 ± 1.29	4.33 ± 1.29	<.001
		(*P* = .232)	(*P* = .010)	(*P* = .082)	
No. of first-stage exams per patient	NYP:	5.8 ± 2.3	4.7 ± 1.7	5.3 ± 2.2	<.001
	HAD:	5.8 ± 2.2	4.4 ± 1.5	4.4 ± 1.6	<.001
		(*P* = .995)	(*P* < .002)	(*P* < .001)	

Results are given as mean ± SD; differences between groups were compared by using generalized estimating equations. *P* values given in parentheses in each cell apply to comparisons between hospitals. *P* values in the last column apply to comparisons across all 3 parity groups. When separate pairwise comparisons were made between P0s and P1-4s, P0s and GMs, and P1-4s and GMs, there was no difference in the mean age or the mean number of first-stage examinations per patient between P1-4s and GMs at Hadassah–Hebrew University Medical Center (*P* = .740 and .612, respectively). Among the P1-4s and GMs at New York Presbyterian Hospital, there was no difference in the mean number of weeks' gestation (*P* = .200) or the mean cervical dilatation on admission (*P* = .881). Each of the pairwise comparisons of the mean ages of the parity groups at New York Presbyterian Hospital were not statistically significant (*P* = .651, .873, and .808 for P0s and P1-4s, P0s and GMs, and P1-4s and GMs, respectively). Results of pairwise comparisons for all other variables were still statistically significantly different between parity groups. *P0,* nulliparas; *P1-4,* lower-parity multiparas, *GM,* grand multiparas; *NYP,* New York Presbyterian Hospital; *HAD,* Hadassah–Hebrew University Medical Center.

tion reaches about 4 cm. At this point, labor in the nullipara would begin to accelerate, but labor in the GM instead remains in the latent phase until dilatation of another 2 cm is attained, and only then accelerates rapidly in the active phase beyond dilatation of 6 cm. However, that ultimate acceleration is at a rate no faster than that of labor in the lower-parity multipara. The result is that the average labor curve of the GM overlaps that of the nullipara initially and overlaps that of the lower-parity multipara in the final phase but is clearly distinguishable from both in the middle portion, at dilatation of 4 to 6 cm.

We stress that our observed average labor curves for each of the parity groups all feature smooth acceleration, not either one straight-line approximation or two conjoined ones for the latent and active phases of labor. Consequently, our data do not enable us to pinpoint a precise demarcation point between two straight-line approximations of the phases of the labor curve. We therefore deem it inappropriate to characterize the curves by any sort of average rate of dilatation, either overall or for the latent and active phases separately.

Remarkably, although Friedman[5] had studied only a small number of GMs, he made very similar observations within his analysis of all multiparous labor.[5] Our results are also consistent with the observation by Petrikovsky et al[7] that labor in GMs begins accelerating at dilatation of 6 cm.[7] Yet, there are some noteworthy differences between

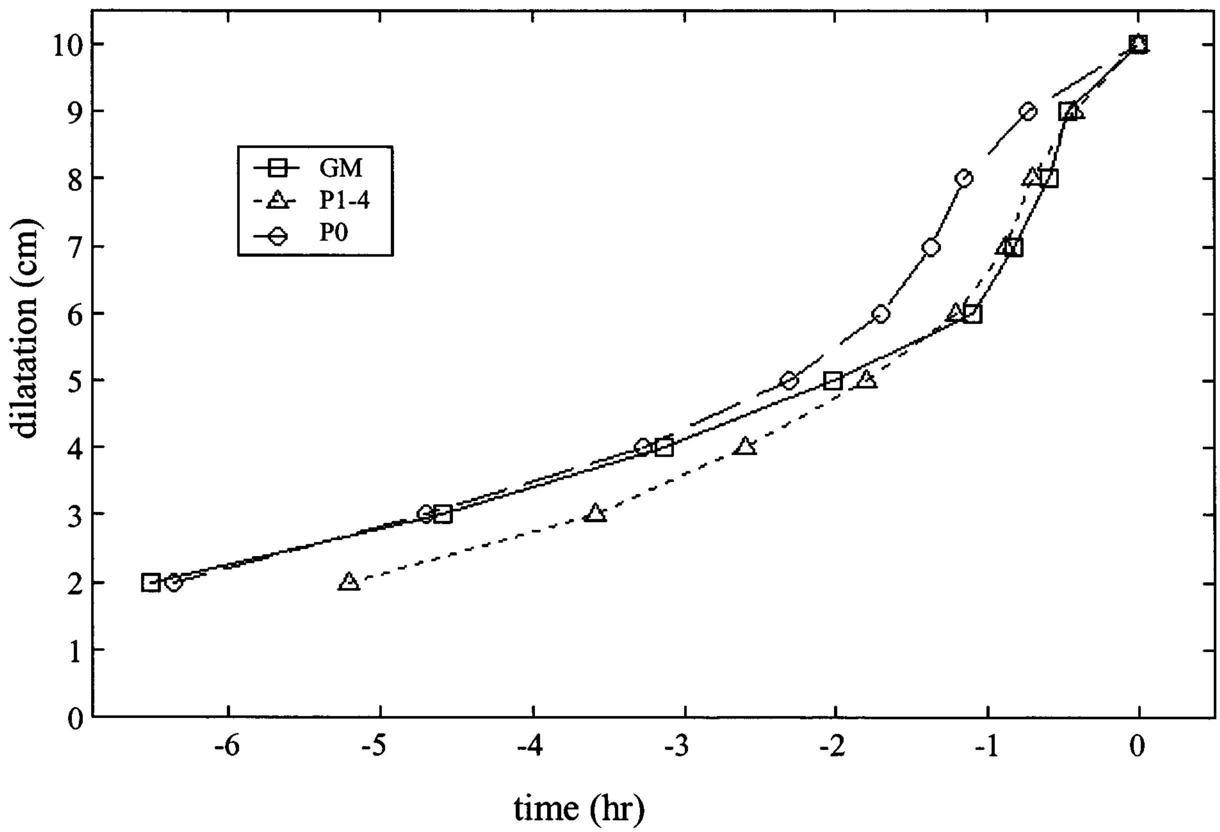

Fig 3. Average first-stage labor curves of different parity groups, adjusted for confounding variables. After adjustment for confounding variables of birth weight, gestational age, hospital, and interventions of amniotomy, oxytocin augmentation, and epidural analgesia, fitted labor curves for each parity group are graphed retrospectively from the point of attainment of full dilatation. The 3 curves are significantly different from each other as determined by pairwise likelihood ratio tests ($P < .001$ for each comparison). *P0,* nulliparas; *P1-4,* lower-parity multiparas; *GM,* grand multiparas.

our study and that of Petrikovsky et al. In contrast to findings by Petrikovsky et al, the general shape of our average labor curves, like Friedman's, appears to be sigmoid. However, we note that the apparent deceleration phase may well be an artifact of the random effects model that was adopted. In deciding to use the time at which full dilatation was attained as the reference time, we necessarily introduce a tendency for the labor curve to flatten out at the end. This is because full dilatation could have occurred earlier than the measured time but not later, so that the average of such times would tend to be somewhat greater than would have been noted if continuous measurements had been available. Consequently, it would be inappropriate to regard the labor curves we derived as definitive evidence for the existence of a deceleration phase.

Although ours is ultimately a retrospective study, we designed it as a cohort study using only criteria and analyses that could be used prospectively. It can be argued that Petrikovsky et al's[7] requirement of at least 5 cervical examinations per patient biases their data against patients with more rapid labors. Because we ultimately restricted our analysis to women with at least 3 first-stage cervical examinations and this excluded more GMs than lower-parity multiparas or nulliparas, a similar criticism might be levied against our study. However, we did not initially require this restriction when identifying our cohort of GMs and selecting their matched control patients, because this could not have been known on admission. Second, we analyzed our excluded patients and determined that their mean cervical dilatation on admission was similar across parity groups but was significantly higher than the mean cervical dilatation on admission of those women from any of the parity groups who had at least 3 examinations. Therefore, it is more likely that we ultimately excluded, from all parity groups, those women who presented to the labor and delivery department in more advanced stages of labor (which was more common among the GMs), but not necessarily the patients whose labor progressed more rapidly.

Another difficulty arose for those few patients (4.1%) who either underwent cesarean delivery before reaching full dilatation or were delivered vaginally but for whom the time of full dilatation was not recorded (usually in precipitous deliveries). The methodologic decision was made to use all the available data for such patients. This decision allowed us to preserve the cohort design of the study, because mode of delivery could not have been known prospectively. Nor could it be known in advance whether a patient's labor might be complicated by fetal distress requiring operative delivery or whether labor might become protracted and end in cesarean delivery because of cephalopelvic disproportion. In the latter case, as with the precipitous deliveries, we reasoned that such outliers, whether rapid or slow, should be represented in a study that aims to construct an average labor curve for a predefined population. That population includes all women who are in normal labor on admission, despite the possibility that their subsequent course of labor may depart from normal. This increases the utility of the results of this study when they are applied in the prospective clinical setting.

The present study examines the labor of a large population of GMs. We have demonstrated that in these women labor initially progresses more slowly, and finally no faster, than labor in their lower-parity multiparous counterparts. The results suggest, but do not prove, that the weakened myometrium of the highly parous uterus is less efficient in overcoming the resistance of the lower uterine segment and cervix, which slows the progress of labor initially. However, once overcome, there is little functional or mechanical resistance to rapid progression to full dilatation, but neither is there any further advantage incurred by high parity. We conclude that once parity exceeds 4, the latent phase of labor lengthens and the active phase progresses no faster than that of the lower-parity multipara. This should have an important clinical application in that "poor progress" beyond dilatation of 4 cm should not be considered abnormal for a GM. She is likely still in the latent phase, and labor should not be expected to accelerate until dilatation of 6 cm is attained. Nor should she be expected to progress through her active phase any faster than is common for lower-parity multiparas. These conclusions, as well as our refined average labor curve for GMs, should assist in the intrapartum management of these patients.

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