The Effects of Competition among Fertility Centers on Outcomes in *In Vitro* Fertilization

By
Anne Steiner

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Abstract

Context To successfully compete for future patients, fertility specialists strive to achieve high pregnancy rates. If the specialist transfers multiple embryos during an *in vitro* fertilization (IVF) procedure to obtain high pregnancy rates, the percentage of high order multiples (HOM) may inadvertently rise.

Objective To measure the effect of competition among fertility centers on outcomes in *in vitro* fertilization.

Design and Setting Retrospective cohort of 408 fertility clinics registered with the Society for Assisted Reproduction as providing IVF services in 2000. Competition is defined as number of clinics in a statistical area. Demand for services is based on the population of reproductive aged women.

Subjects 381 fertility clinics reporting clinical outcomes

Main outcome measures: The clinic high order multiple gestation rate (percentage of pregnancies that were high order multiples) and age adjusted pregnancy rate

Results The number of clinics in an area of competition ranged from 1-22. HOM rate per clinic ranged from 0% to 50%. As demand increased, competition increased. As competition increased the number of high order multiples per clinic decreased. In areas of low competition (1-2 clinics) the clinic rate was 8.46%, in areas of intermediate competition (3-7 clinics) 8.39%, and in areas of high competition (8-22 clinics) 8.24%. In areas with intermediate demand, high levels of competition resulted in fewer high order multiples than intermediate competition (RR 0.56, 95% confidence interval 0.36,0.89) or low levels of competition (RR 0.57, 95% confidence interval 0.35, 0.94). Age adjusted pregnancy rates did not differ by level of competition.

Conclusions Based on this data, the risk of high order multiple gestation decreases with increasing competition between clinics; however, pregnancy rates are unaffected.

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Problem Statement

In the year 2000, 180.5 out of 100, 000 live births were triplets or other high order multiple births. Although this number is down from its peak of 193.5 in 1998, it is still significantly higher than the 1980 rate of 37.[1] These multi-fetal pregnancies are associated with adverse fetal implications such as prematurity, and maternal complications such as pre-eclampsia and uterine atony with hemorrhage. In addition, there are large health care costs associated with the multi-fetal pregnancy and its related complications.[2] Preventing high order multiple pregnancies can reduce costs and decrease both maternal and infant mortality.

The use of assisted reproductive technology (ART) services, such as intrauterine insemination, ovarian hyperstimulation, and *in vitro* fertilization (IVF) is associated with an increased risk of multi-fetal pregnancy.[2] In 1998, 11% of IVF pregnancies were high order multiples (HOM), three or more gestations.[3] In fact, ART accounts for 43% of the total number of HOM births in the United States.[4,5]

The association between HOM and IVF is especially concerning considering the large demand for infertility services. Approximately 1.2 million women received care for infertility in 1995.[6] Many of these women sought ART services. By 1998, 27,300 (0.7%) of the 3.9 million births in the United States were the result of ART.[2]

Background
Previous Literature

Several researchers have hypothesized and studied risk factors for high order multiple pregnancies (See Attachment A). Different areas of research have included access to care, physician practice styles, system level interventions, patient demographics and medical history, and patient attitudes. Few researchers have studied the effects of access to care on the rate of high order multiples. Jain et al. found that mandated insurance coverage for IVF lead to a decline in the percentage of HOM.[7] However, other researchers failed to find such an association.[8]

The medical history of a patient may also contribute to the risk of HOM. Some authors have found that increasing number of previous attempts at IVF resulted in a lower risk of multiple gestation.[9,10] However, Basil et al did not observe this association in a retrospective study.[11] Studies researching the effects of age have been even more inconsistent, with some studies finding that age decreases the risk of multiples,[9,12,13] and others showing that age has no association.[11,14] In fact, Senoz et al found a nonsignificant trend of increasing risk with age.[15] These differences may more reflect physician practice styles than a medical risk factor. Physicians transfer more embryos in older women than younger women, however the difference in the numbers transferred varies by physician.

Embryologic factors are a more frequently studied subject. Multiple articles have shown a significant association between number of embryos transferred and risk of HOM.[10,11,13-15] However, these studies differed in their recommendations on the number of embryos to transfer, two or three, to maximize pregnancy rates and minimize the multiple risk. On the other hand, two studies have clearly shown that blastocyst transfer can lead to lower multi-fetal pregnancies[16,17]. One study showed that increased embryo quality led to a higher risk of multiples, but this study has not been confirmed.[11] Finally this same study showed that the total number of embryos generated was not associated with HOM risk. Clearly the evidence on risk factors for high order multiples is not conclusive.

Hock et al used a survey to assess the role of physician practice patterns on multi-fetal pregnancies.[18] He found that providers varied in their choice of ART, IVF or superovulation, by region in the United States. In addition, he found that almost all physicians used informed consent for reproductive procedures. The majority of physicians discussed selective reduction (98.3%) and the complications associated with multiple gestation. Physicians most commonly cited maternal morbidity, preterm labor, fetal neurologic sequelae, and fetal death as the complications of multiple gestation pregnancies. These discussions may influence patient knowledge and attitudes towards HOM.

Goldfarb et al assessed patient's attitudes towards multiple pregnancies by interviewing couples currently undergoing ART.[19] He found that patients preferred triplets to no pregnancy in 88%-98% of cases, and 56-78% preferred quadruplets to no pregnancy. Interestingly, attitudes toward HOM varied by choice of ART procedure.

To reduce the adverse consequences of HOM, the American Society for Reproductive Medicine published guidelines in 1999 on the appropriate number of embryos to transfer. These guidelines stress the use of informed consent and provide guidance on the number of embryos to transfer based on age, prognosis, and donor status.[20] The subsequent decline in HOM would imply that these guidelines have been successful. The rate of IVF pregnancies that are high order multi-fetal gestations dropped from 11% in 1998 to 7.7% in 2000.[21] Engman et al found that legislation limiting the number of embryos transferred to three, failed to significantly reduce the risk of multiple birth in England.[9]

Current Research Needs

In 1992, the Fertility Clinic Success Rate and Certification Act (P.L. 102-493) called for the reporting and publicizing of the pregnancy rates from all fertility clinics. These success rates are obtained and validated by the individual clinics and published on the World Wide Web by the Centers for Disease Control and Prevention (CDC), with consultation from the American Society for Reproductive Medicine, Society for Assisted Reproductive Technology, and RESOLVE: The National Infertility Association.[21] These published success rates appear to influence a patient's choice of a fertility clinic more than the price of the IVF therapy, distance of the clinic from home, opinion of friends about the clinic, or recommendation of a general practitioner or gynecologist.[22] Thus, a high pregnancy success rate is important for both economic reasons and the reputation of the clinic. The goal of achieving pregnancy with each in vitro fertilization attempt may lead physicians to transfer multiple embryos.

Does competition for success amongst fertility clinics indirectly result in increased rates of high order multiples? Experts in the field of reproductive endocrinology have proposed anecdotally that competition between fertility clinics has induced physicians to transfer multiple embryos in order to improve success rates.[23,24,25] An empirical analysis to examine the role competition plays in increasing the number of high order multiples is needed. This requires a methodologically sound means of measuring competition.

Methodological Considerations in Measuring Competition

A measurement of competition between fertility clinics has yet to be established. Therefore, a way of measuring competition for each clinic must be generated. In a review on measuring competition in health care by Baker in 2001, the author stresses the need to consider 5 conceptual issues when studying competition: 1) a definition of the product under study, 2) a measure of competition, 3) a definition of the market, 4) identification of forces that modify market dynamics, and 5) the role of health maintenance organizations. [26]

Research previously cited on quantifying the degree of competition, uses a variety of measures for market competition. The number of firms/hospitals (N) in a market area can be counted and used as a measure of competition in that market area. Robinson and Luft counted the number of hospitals within 15 miles of each other, and used the number, N, as the measure of competition.[27] Gift et al and Dranove et al. considered all hospitals within the same metropolitan area as the number, N.[28,29] Although this method is commonly used and easily implemented, it fails to take into consideration the relative sizes of firms.

The Herfindahl-Hirschman Index (HHI), another measure of competition, is calculated by taking the sum of squared firm market shares in an area [(percent market share for clinic A)^2+(percent market share for clinic B)$^{2+\cdots}$.][28] Market shares for hospitals are usually assigned based on hospital discharges. HHI considers both the relative size and distribution of the firms in a market. As the number of firms increases or the share of the market becomes more evenly distributed, HHI approaches zero, thereby representing high levels of competition. The Federal Trade Commission uses the HHI measurement for anti-trust monitoring.

Another way to define competition is to quantify the extent to which two hospitals/firms' markets overlap. The market of a hospital is defined by the zip codes of those patients discharged from the hospital. Zwanzinger and Melnick used a ZIP code-based HHI to measure competition in multiple studies.[30,31] Sohn also used zip codes to define and compare overlap between hospital markets in the Los Angeles area using a method defined as the relational approach.[32]

How do the various methods of measuring competition compare? Bernstein and Gauthier point out that there is no consensus agreement on the perfect method of measuring competition.[33] Many previous analyses of competition have been undertaken for a wide variety of reasons by academic researchers, policymakers, competitors, and payers. Their definitions of competition varied by the needs and perspective of the researcher. Bernstein and Gauthier further state that all commonly used measures can be criticized for their inability to capture the true nature of competition. Most markers fail to capture local market conditions, such as patient allegiance to certain hospitals or provider groups, restrictions on HMO referrals, or perceived competition by the firm management.[33] Sohn found that the various measurements of competition varied significantly in the geographic area she studied with only 50% concordance between any two methods. She asserts that the N method or radial approach overestimates the level of competition in urban markets and underestimates it in rural areas.[32] However, Garnick et al. found that all methods produced comparable measurements of competition.[34]

Many geographic areas have been used to define health care markets. Robinson and Luft drew a fixed radius, 15 miles, around each firm to define an area. Unfortunately a 15-mile radius in Boston, MA may not be similar to a 15-mile radius in Greensboro, NC. Fisher and Wennberg[35] used the Dartmouth Atlas of Healthcare, which defines 306 hospital referral regions based on patient travel patterns. Brasure et al used Health Service Areas (HSA)[36] to analyze competitive behavior among physicians.[37] Health service areas are defined using 1988 Medicare data on short hospital stays. There are four alternative definitions of HSAs, two of which base the definition of a HSA on metropolitan statistical areas.[36]

Metropolitan statistical areas (MSA) have a large population nucleus with surrounding communities that share a high degree of economic and social integration with the core. MSAs are established by the Office of Management and Budget using set standards. Each MSA must have one city with 50,000 or more inhabitants and a total metropolitan area of at least 100,000. Counties are the components of MSAs. In MSAs with populations greater than one million the area can be divided up into Primary Metropolitan Statistical Areas (PMSAs) only if the counties in the PMSAs are highly economically and socially integrated.[38]

Other researchers have used metropolitan statistical areas to define a health market. Deaton and Lubotsky compared mortality rates between MSAs.[39] Anderson et al. used MSAs to compare community wide access to medical care.[40] Hendryx et al compared social capital and access to medical care among 22 MSAs.[41]

Thus a number of factors need to be considered when measuring competition in health care markets. Previous studies offer a variety of measurements of competition and geographically defined market areas. Because competition among fertility centers has yet to be defined or quantified, previously applied methods of measuring competition must be adopted.

Methods

Study Question

This study analyzes the effect of competition among fertility centers on outcomes in in vitro fertilization, specifically high order multiples and pregnancy rates. We hypothesize that competition between clinics results in higher rates of HOM and higher pregnancy success rates. (H_0=competition has no effect on outcomes or decreases the number of HOM) The alternative hypothesis is that competition between clinics results in higher rates of high order multiples and higher success rates.

Data Source

The total number of high order multiple pregnancies occurring from fresh embryos with non-donor eggs is currently available from the 2000 Assisted Reproductive Technology Success Rates accessible from the world wide web.[21] These success rates are published and placed on the World Wide Web by the Centers for Disease Control and Prevention.[21] All clinics that provide artificial reproductive services are required by law to submit their pregnancy rates to the Society for Assisted Reproductive Technologies (SART). The clinic directors then verify the data. SART maintains a list of all ART clinics and their reported success rates and releases that data to the CDC. From 1995-1999 the CDC conducted on-site validation visits, where they randomly selected records from 1321 cycles in 29 clinics. The discrepancy rate was found to be less than five percent. Starting with the 2000 report, the CDC did not conduct random validation visits. Instead, SART conducted a clinic-specific self-validation process. Two hundred and ten of the 377 clinics contacted (63%) completed the self-validation worksheets and a total of 2098 ART cycles were validated. Discrepancy rates were calculated and found again to be low. The weighted discrepancy rate for number of fetal hearts on ultrasound was 3.3%.[21] In 1999 the reported rate was 3%.[42]

Only HOM pregnancies occurring from fresh non-donor eggs were studied. HOM pregnancies occurring from frozen embryos or donor eggs are not reported by the CDC. Twin pregnancies, although reported by the CDC, are not included as high order multiples. The percentage of live births with multiple infants underestimates the number of pregnancies with multiple fetuses. Patients may choose to selectively reduce multi-fetal pregnancies, thus decreasing the number of multi-fetal pregnancies delivered.

Population

The unit of analysis for this study is the clinic. All fertility clinics listed by the Society for Assisted Reproductive Technology as providing IVF services in 2000 in the United States, including Puerto Rico, are included. On the list were 408 clinics. All 408 were included in the calculation of competition. Twenty-five of the 408 clinics (6%) failed to submit and validate their clinic data, and therefore were not included in the analysis. In addition, clinics that provide the majority of their care to military families were excluded from the analysis. These two clinics were Wilford Hall Medical Center and The ART Institute of Washington, Inc. at Walter Reed Army Medical Center. This left 381 clinics in the final analysis.

Independent and Dependent Variables

The outcomes analyzed were 1) HOM rate, percentage of HOM pregnancies per pregnancy event over one year and 2) age adjusted pregnancy rate, number of pregnancies/number of initiated cycles over one year and 3) average number of embryos transferred. Data on in vitro fertilization outcomes were extracted from the 2000 Assisted Reproductive Technology Success Rates.[43] For each clinic, number of initiated cycles by age group, pregnancy rate by age group, average number of embryos transferred by age group, and HOM rate by age group were recorded. Initiated cycles are the total number of IVF cycles summed across all patients started at a clinic. Total pregnancies, total number of HOM pregnancies, and clinic HOM rate were calculated from this data and used for analysis. In addition, an age adjusted pregnancy rate was calculated for each clinic using the national age distribution to adjust for the differing age structure among clinics.

Competition

Competition was the main independent factor studied. It was defined as the number of clinics providing IVF services in the delineated market area. For this paper we have chosen to use metropolitan statistical areas (1990 standards) as the geographic market. The addresses for reporting and non-reporting clinics were downloaded from the CDC website. Using the zip codes for each clinic, the county and its designated MSA and, if applicable, its PMSA were obtained. The area of competition was defined as the PMSA. If the clinic was not located in a PMSA, the MSA was defined as the area of competition. If a MSA was not available, the county was defined as the area of competition.

The number of clinics in each area of competition was calculated and then categorized. Areas with 1 to 2 clinics were defined as displaying low levels of competition, 3 to 7 clinics as intermediate competition, and greater than 7, high competition. This level of competition was then assigned to each clinic within that area.

Covariates

Demand

Demand is defined as the universe of all potential users of IVF services. Densely populated urban areas may be able to accommodate more than one fertility center. Although centers in these areas compete for patients, the demand for services may be greater, thus mitigating the competitive pressure.

Demand for services was based on the female population between the ages of 25 and 44 in each area of competition. 98.3% of all women seeking in vitro fertilization in 2000 were in this age range.[43] The population of these women in each area of competition (MSA, PMSA, or county) was obtained using the 2000 census.[44] Demand was categorized, where clinics in areas with a population less than 130,000 females were assigned a low score and clinics in areas with a population with greater than 600,000 females was assigned a high score. Clinics in areas with numbers between these two were assigned an intermediate score. Cutoffs for high and low levels of demand and competition were based on the twenty-fifth and seventy-fifth percentiles.

Insurance

The final independent variable delineated whether insurance covered IVF services in the clinic's location. Clinics were categorized in three groups: full insurance coverage mandated, partial insurance coverage mandated, or no insurance coverage mandated.

Statistical Analysis

Statistical analysis was performed using STATA 7.0 statistical software (College Station, TX). First, the mean HOM and pregnancy rate for each level of competition stratified by level of demand was calculated. HOM rate was not normally distributed. We transformed HOM by taking the square root. Pregnancy incidence was normally distributed. With these two normally distributed outcomes, two way ANOVA was used to test equality of the means between levels of competition and demand. P-values less than 0.05 were considered significant.

Next, an analytic model was constructed to study the effect of competition on HOM within each level of demand. Eight combinations of competition and demand were coded using indicator variables, with low competition in an area of low demand as the referent indicator. Indicators for areas with high competition and low demand and areas with low demand and high competition were not included in the model because of zero observations in these groups. Also insurance coverage was coded using two indicator variables with no mandated insurance as the referent indicator. We constructed the following model:

HOM rate= $\alpha + \beta_i X_i + \gamma_j Z_j$+residual

α= intercept, β_i=additional risk of HOM associated with X_i level of demand and competition, i=1,2,3..7 (e.g. X_1=1 if observation in a area with low competition and intermediate demand and X_1=0 otherwise), γ_j= additional risk of HOM associated with Z_j type of insurance coverage mandated, j=1,2 (e.g. Z_1=1 if partial coverage for IVF mandated, 0 otherwise)

Because HOM rate was not normally distributed, linear regression analysis was inappropriate. Poisson regression appeared more appropriate; however, an important assumption in Poisson regression is that the variance equals the mean. Because over-dispersion was noted for our outcome (HOM mean 4.58, variance 43.4), we used negative binomial regression, which adds a random effect to represent unobserved heterogeneity, correcting for the extra variance.[45] Using negative binomial regression with the number of HOM in a clinic as the dependent variable and number of pregnancies in each clinic as the exposure, combinations of competition and demand as the independent variables, and insurance status as the covariate, relative risks were calculated.

A second regression model was constructed to evaluate the association between competition and pregnancy rate using the same model in the HOM analysis. However linear and log linear regression were used to calculate adjusted relative risks and adjusted risk differences.

Only the average number of embryos transferred for women 38-40 was normally distributed. For this reason, only this age group was selected to study the effect of competition on the number of embryos transferred. Categorical variables for competition, demand, and insurance and a continuous variable for embryos transferred were created. A third model was constructed.

$$\text{Embryos} = \alpha + \beta_1 X + \beta_2 Z_1 + \beta_3 Z_2 + \text{residual}$$

α= intercept, β_1=percent change in embryos transferred per increase in one level of competition (X), β_2= percent change in embryos transferred per increase in one level of demand (Z_1), β_3=percent change in embryos transferred with a change insurance mandate (Z_2)

Linear regression was used to obtain the percent change in embryos transferred per increase in one level of demand.

Results

The number of clinics in each area of competition ranged from 1 to 22. The population base of reproductive age women in the market areas ranged from

2,677 to 1,557,904. One hundred three clinics (25%) were located in areas with fewer than 130,000 female residents between the ages of 25 and 44, 101 (25%) in areas with greater than 600,000, and 204 with numbers in between. The percentage of HOM for individual clinics ranged from 0 to 50% (mean, 8.36).

As demand for services increased, the number of clinics in the area increased. In areas with less than 130,000 women, the number of clinics averaged 1.65 (Standard deviation, 0.801). In areas with greater than 130,000 women but less than 600,000 there were 4.59 (standard deviation, 2.16). In areas with greater than 600,000 women, the number of clinics averaged 15.65 (standard deviation 5.62).

Mean clinic HOM rate declined as the level of competition increased (two-way ANOVA p=0.006). Mean percentage for low level of competition was 8.43%, intermediate 8.39%, and high 8.24%. Level of demand increased as the proportion of HOM declined (two-way ANOVA p=0.002). Mean percentage for low level of demand was 7.69%, intermediate 8.22%, and high 9.33%.

Table 1. Mean HOM rate among fertility clinics by level of competition and demand (standard deviation), 2000

		Level of competition			
		1 (1-2 clinics)	**2 (3-7 clinics)**	**3 (8-22 clinics)**	**Overall**
Level Of Demand	**1 (low)**	8.05 (6.37)	4.55 (5.94)	___	7.69 (6.39)
	2 (intermediate)	9.45 (9.61)	8.29 (6.17)	5.53 (7.98)	8.22 (7.07)
	3 (high)	___	13.60 (14.09)	8.82 (7.46)	9.33 (8.43)
	Overall	8.43 (7.37)	8.39 (7.02)	8.24 (7.61)	8.36 (7.27)

After adjusting for level of demand and insurance coverage, clinics with higher levels of competition were significantly more likely to have a lower HOM percentage compared clinics with low levels of competition or clinics with intermediate levels of competition in areas of intermediate demand.

Table 2. Measures of Association between HOM and competition among fertility clinics stratified by level of demand, 2000

Level of Demand	Level of Competition	Relative Risk (95% Confidence Interval)	Relative Risk* (95% Confidence Interval)
Low	Intermediate competition versus low competition	0.71 (0.39, 1.29)	0.69 (0.38, 1.25)
Intermediate	Intermediate competition versus low competition	1.02 (0.80, 1.31)	1.02 (0.80, 1.29)
	High competition versus low competition	0.59 (0.36, 0.97)	0.57 (0.35, 0.94)
	High competition versus intermediate competition	0.58 (0.37,0.91)	0.56 (0.36, 0.89)
High	High competition versus intermediate competition	1.03 (0.68, 1.56)	1.09 (0.718, 1.65)

*Adjusted for insurance status

The age adjusted pregnancy rate did not differ significantly between the levels of demand (Two-way ANOVA, p=0.481) or levels of competition (Two-way ANOVA, p=0.872). No statistically significant adjusted measures of association were found between levels of competition within a level of demand.

Average number of embryos transferred in women ages 38-40 did appear to significantly rise with an increase in each level of competition (RD 0.10%, 95% CI 0.012, 0.197). However, after adjusting for level of demand and insurance status the effect of competition was even smaller and failed to be significant (RD 0.07%, 95% CI -0.095,0.239).

Table 3. Age adjusted pregnancy rate for fertility clinics (standard deviation), 2000

		Level of competition			
		1 (1-2 clinics)	**2 (3-7 clinics)**	**3 (8-22 clinics)**	**Overall**
Level Of Demand	**1 (low)**	28.09 (10.43)	26.46 (10.84)	____	27.92 (10.43)
	2 (intermediate)	28.41 (9.70)	31.82 (9.84)	29.75 (10.91)	31.05 (9.95)
	3 (high)	____	27.01 (8.04)	29.60 (11.35)	29.32 (11.04)
	Overall	28.17 (10.2)	31.19 (9.89)	29.62 (11.22)	29.83 (10.41)

Discussion

The results of this study suggest that competition is associated with a lower risk of high order multiples. These findings contradict the previously hypothesized relationship between competition and HOM that an increase in competition would lead to greater HOM. However, no other studies have attempted to empirically quantify the effects of competition on HOM.

To accept our conclusion, one must agree that the methodology of this study is valid. Specifically, one must assume that this measure of competition accurately depicts the degree to which competition actually is perceived and occurs among fertility centers.

The number of clinics in a market area, a measure of competition, was selected mainly due to feasibility. A possible alternative measure would be HHI. The total number of cycles could be used to represent the market share of a clinic.

However, a number of clinics do not report their outcomes. A measure of competition could not be assigned for every market area with a non-reporting clinic, which would generate a large amount of missing data. Any imputation of their market share without further information on these clinics would add bias.

There is some concern that a measure of competition such as HHI that incorporates market share would more accurately describe competition among fertility centers. Previous research has shown that large hospitals generate more competition than small hospitals but that the size of the hospital does not affect the amount of competition received.[32] This would imply that adjusting for market share in the measure of competition may be important. However, Baker points out that the number of firms in a geographic area and HHI are typically correlated, suggesting that both measures of competition would likely produce similar results.[26]

In addition, it is very important to use a valid geographic area for small area analysis. Unfortunately no gold standards exist, and researchers are limited by the available data. Defining a geographic area by drawing a set radius around a clinic fails to accommodate for differences in urban and rural regions. Geographic areas used in previous literature, such as HSAs, are inappropriate for fertility clinic analysis. HSAs have been generated using Medicare hospital data. IVF patients are younger than the Medicare population and use clinic not hospital services. In addition, IVF is infrequently covered by insurance. In that sense, IVF services are more similar to a commodity than a health service. Therefore

MSAs, which are defined by economic and social integration, are more appropriate choice for the geographical unit for this study.

Our use of metropolitan statistical areas may be a poor substitute for the actual market for *in vitro* fertilization services. Without information from clinics about their patient base, we are unable to verify the appropriateness of MSAs as a substitute. Research on the utilization of ART services would be improved by studies that look into catchement areas for individual IVF clinics.

Also, the use of MSA population to define demand may underestimate the actual demand. Eighty percent of the population in the United States lives in Metropolitan Services Areas.[46] However, women in metropolitan statistical areas without a fertility clinic (over 50%) and women not living in a MSA also seek fertility services. Future research may wish to elucidate the migration pattern for these regions.

Although the majority of clinics are probably independent, some may be managed by one parent institution. It is unlikely that these clinics would compete, but would rather share patients and health care providers. We could not account for affiliated clinics in this analysis. However, we hypothesize that the number of these associations are relatively few.

The fertility community generally accepts the CDC data set as valid for research. Jain et al looked at the interaction between the provision of insurance and pregnancy success rates and higher order multiple rates using the CDC data set.[7] In addition, authors in SART have used the data to correlate clinic volume with success rates.[3,21,42] Finally, Feigenbaum used the Fertility Clinic Reports to study the use of homologous and donor embryos in women over forty.[47] Reynolds et al challenged this use of aggregate level data to study patient level outcomes.[8] Since our unit of analysis is the clinic and not the patient, we feel that aggregate level data are appropriate and valid.

There is limited outcome information on those clinics not reporting their data. However, this is a small subset of the clinics. Of the 25 clinics that did not report in 2000, 11 clinics did not report in 1999, 6 reported in 1999 under the same name or in the same location, and 8 clinics were new to the list. The median HOM percentage for those clinics that did report in 1999 but not in 2000 was 14.9%. The total number of cycles initiated per clinic reporting in 1999 ranged from 18 - 231.

Establishing why certain clinics do not submit their data may improve the validity. Non-reporting clinics appear to be concentrated in areas of low competition, which may bias the results. If they perform few ART procedures, other clinics in the area may not see them as competition. If they have higher HOM rates, as implied by the few clinics that did report in 1999, the difference between areas with low versus high competition may be greater. However, more information would be necessary to validate this hypothesis.

Currently, insurance companies do not cover IVF in the majority of states. Therefore this study did not seek to address the influence of health maintenance organizations on competition. If insurance mandates become more widespread, the role of HMOs will have to be explored. It is not known if physicians will change their practice patterns to obtain contracts with HMOs. HMOs may use similar standards such as quality, success rates, and price to monitor clinics.

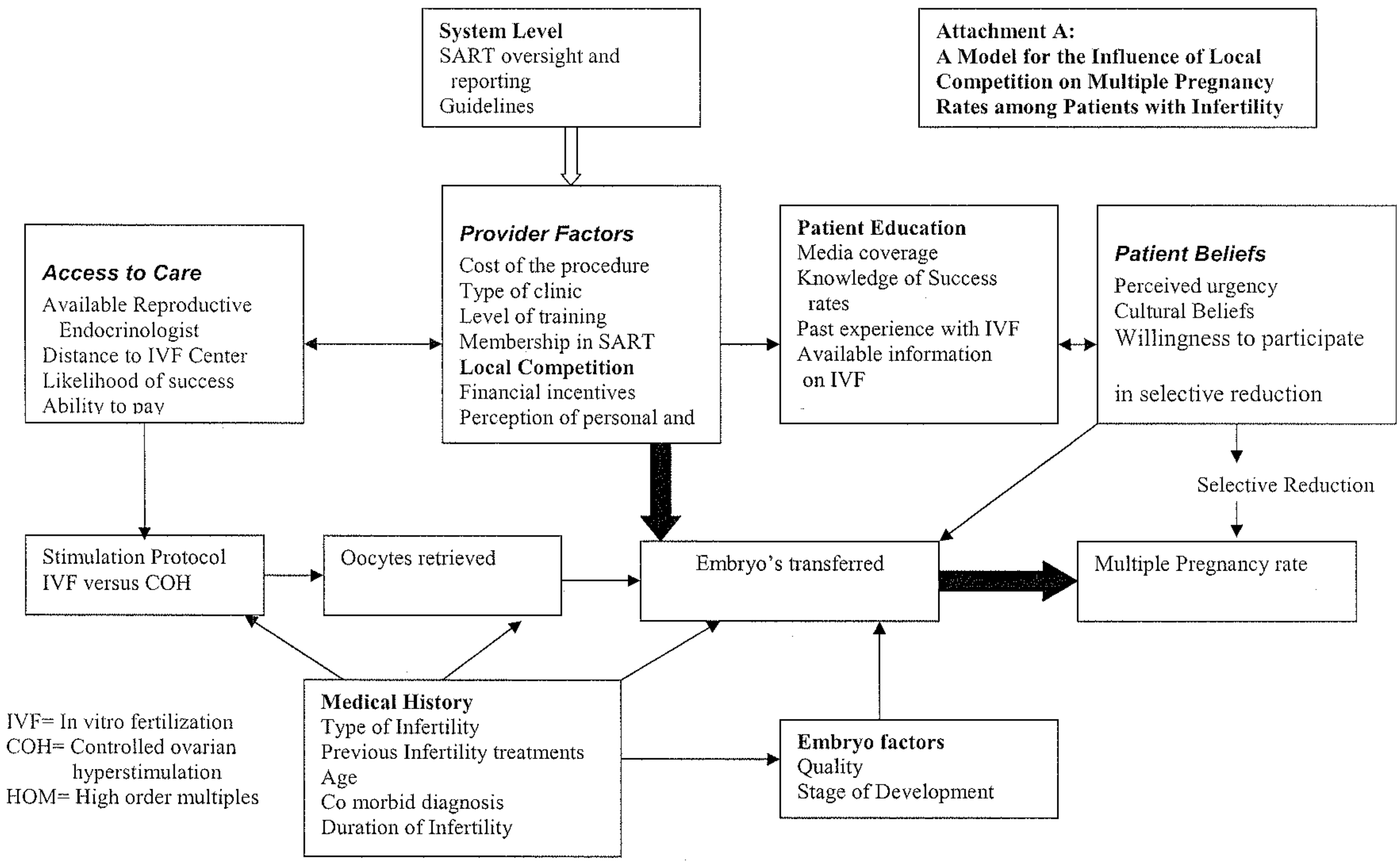
The strengths of this study are in its measurement of competition and in the measurement of the outcomes. In addition, it adjusts for insurance coverage, which has previously been shown to influence not only competition but also HOM rates. Finally, it attempts to delineate the factors, such as number of embryos transferred that may be the intermediaries between competition and HOM.

I theorized that competition between fertility centers would result in greater numbers of high order multiples. The results of this analysis do not support this hypothesis. However, the implication that competition improves quality of care is not unique in healthcare. Kessler and McClelen found that high competitiveness resulted in lower mortality and complication rates after heart attacks[48]. An analysis by Sari in 2002 showed that increasing a hospital's market share, and subsequent decline in competition, resulted in a decline in quality[49]

Why high order multiple rates decline in areas of high competition or in areas with fewer reproductive women, we can only hypothesize. Clinics with high levels of competition are not transferring significantly fewer or greater numbers of embryos. Perhaps education and guidelines by the American Society for Reproductive Medicine and the Society for Assisted Reproductive Technology on appropriate numbers of embryos to transfer have been successful. Instead of transferring greater numbers of embryos to improve pregnancy rates, physicians may seek other means to increase pregnancy rates such as blastocyst transfers and more selective choice of candidates for IVF.

Other authors have attempted to delineate the risk factors for HOM. Reducing the number of embryos transferred and using blastocysts have been shown to be potentially useful. However, this study tries to identify another means to intervene. Before encouraging further competition among clinics by sponsoring additional IVF clinic openings, we would suggest more research on physician's attitudes and practices in areas of high competition. However, competition should no longer be viewed as the culprit in IVF.

Most people recognize the negative impact that high order multiples can cause. It is imperative that we identify and quantify the factors that may contribute to this problem. Future efforts to curtail high rates will depend on recognizing and controlling factors in the health care system that contribute to this unintended outcome.



Attachment A:
A Model for the Influence of Local Competition on Multiple Pregnancy Rates among Patients with Infertility
System Level
SART oversight and reporting
Guidelines
Access to Care
Available Reproductive Endocrinologist
Distance to IVF Center
Likelihood of success
Ability to pay
Provider Factors
Cost of the procedure
Type of clinic
Level of training
Membership in SART
Local Competition
Financial incentives
Perception of personal and
Patient Education
Media coverage
Knowledge of Success rates
Past experience with IVF
Available information on IVF
Patient Beliefs
Perceived urgency
Cultural Beliefs
Willingness to participate
in selective reduction
Selective Reduction
Stimulation Protocol
IVF versus COH
Oocytes retrieved
Embryo's transferred
Multiple Pregnancy rate
Medical History
Type of Infertility
Previous Infertility treatments
Age
Co morbid diagnosis
Duration of Infertility
Embryo factors
Quality
Stage of Development
IVF= In vitro fertilization
COH= Controlled ovarian hyperstimulation
HOM= High order multiples

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