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## ORIGINAL ARTICLE *Infertility*

# The impact of introducing patient co-payments in Germany on the use of IVF and ICSI: a price-elasticity of demand assessment

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**BACKGROUND:** Authorities concerned by rising healthcare costs have a tendency to target reproductive treatments because of the perception that infertility is a low priority. In 2004 German health authorities introduced a 50% co-payment for patients, in an effort to save cost. We explored the impact of this pricing policy on the utilization of reproductive treatments in Germany.

**METHODS:** Using aggregated annual *in-vitro* fertilization (IVF) and intracytoplasmic sperm injection (ICSI) cycle data in Germany, we evaluated the relationship between changes in the number of cycles in relation to changes in costs faced by consumers following the introduction of a patient co-payment from 'no fees' to €1500–2000 by estimating the short-run price-elasticity of demand. The impact of introducing patient co-payments for IVF/ICSI on the likelihood of switching to other low-cost fertility treatments was evaluated using the cross-price elasticity methodology.

**RESULTS:** The reduction in demand for IVF and ICSI cycles in the year following the introduction of patient co-payments resulted in elasticities of −0.41 and −0.34, respectively. The price-elasticity for the combined reduction of IVF/ICSI in relation to the co-payment was estimated to be −0.36. The cross-price elasticity for clomifene was close to zero (−0.01) suggesting that demand for these interventions are independent of each other and no substitution occurred.

**CONCLUSIONS:** We report price elasticities for IVF and ICSI of −0.41 and −0.34 after introducing a €1500–2000 co-payment. These findings likely represent short-run elasticities that are likely to vary over time as factors that influence the supply and demand for fertility treatments change.

**Key words:** price-elasticity / cross-price elasticity / co-payment / *in-vitro* fertilization / fertility treatments

## Introduction

Over the past decade demand for (i.e. utilization of) assisted reproductive technologies (ART) has steadily increased (Andersen *et al.*, 2007, 2008). Demand for ART has increased for a variety of reasons including couples delaying time to first pregnancy and consequently increasing the reliance on ART, an increasing public awareness regarding available treatments, a generous public subsidy in some countries, and a growing acceptance of the technology for conceiving children (Heck *et al.*, 1997; Adashi *et al.*, 2000).

Despite increasing demand for treatment, the provision of services by national and private health insurers is often limited (Jones and Cohen, 2004; McWhirter and McQueen, 2000). The primary

reasons for not funding or for limiting funds through public and private health services are costs and the perception that infertility is not a disease (Redmayne and Klein, 1993). In many cases, the necessity to allocate scarce resources to those deemed of most need has led to the establishment of criteria for rationing treatments (Kennedy *et al.*, 2006). For those unable to access publicly subsidized treatments, affordability can be a problem and as a result many infertile couples go without treatment or discontinue treatment (Dawson *et al.*, 2005; Rajkhowa *et al.*, 2005).

Because costs and affordability are important factors that can influence a couple's access to treatment, it is important to understand the relationship between prices and consumer demand. The demand for any product or service reflects the relationship between the quantity

consumed at any given price and ART is likely no exception. To understand this relationship, economists often measure the change in quantity demanded in response to a price change to establish the price-elasticity of demand (Tewari and Singh, 2003). This is a simple ratio of the change in demand over a period of time in relation to changes in price over the same period of time to explain how responsive demand is in relation to its price. Price elasticity estimates are used by policy-makers and commercial analysts to predict how future price changes, in this case patient co-payments, are likely to influence demand for products and potential revenue consequences in the case of commercial organizations.

With the above points in mind, we sought to measure the price-elasticity of demand associated with a policy intervention in Germany that required couples to pay 50% of the costs for *in-vitro* fertilization (IVF) and intracytoplasmic sperm injection (ICSI) from January 2004 onwards (Thaele and Uszkoreit, 2007). This natural experiment provides us with an opportunity to assess the price-elasticity of demand for IVF and ICSI based on changes in utilization of fertility treatments observed following introduction of the co-payment. Furthermore, to assess how patients and doctors respond to high co-payment charges, we evaluated whether changes in IVF/ICSI co-payments would affect the demand for alternative cheaper but less effective fertility treatments such as clomifene.

# Materials and Methods

This study was a retrospective analysis on the number of IVF and ICSI cycles in Germany reported by the Deutsches IVF registry (DIR) for the period from 1999 up to and including 2004 (DIR, 2004; DIR, 2005). The dates were selected to provide a historical perspective to the growth in use of IVF and ICSI prior to introduction of the German healthcare modernization law which mandated a 50% co-payment for all treatment costs in January 2004 for publicly insured couples. All IVF/ICSI clinics in Germany are required by law to report utilization statistics to the DIR, therefore providing comprehensive statistics on the annual number of cycles performed. The DIR cycle data is available in aggregated format for all cycles, both self paid and reimbursed, although the majority of cycles in Germany are conducted within the public reimbursement system (Statistisches Bundesamt, 2007; GBE, 2006).

The primary price-elasticity estimates were based on IVF/ICSI volumes changes observed between 2003 and 2004 which corresponds with the introduction of the co-payment. However, to account for the demand surge that occurred in 2003 prior to implementing the policy reform, a second price-elasticity calculation was derived based on the average annualized growth in the 5 years prior to the co-payment being

introduced. The cycle volume data on which the elasticity estimates are based are provided in Table I.

## Price-elasticity of demand equation

To estimate the responsiveness of consumer demand to changes in prices two methodologies are commonly used to estimate the price-elasticity of demand: (1) 'arc' price-elasticity of demand and (2) 'point' price-elasticity of demand. For our purposes, the arc methodology is better suited for considering large increases in price as were experienced in Germany in 2004 (Quesada, 2002; Tewari and Singh, 2003; Chambers *et al.*, 2009). For criticisms of the arc methodology, interested readers are referred to the publication by Sánchez-Moreno and Ruiz-Tamarit (2002).

The formula for deriving the ratio of change in cycles to change in price is shown below. The elasticity of demand ($E_d$) is the ratio between the changes in demand for IVF and ICSI treatments in relation to the change in price paid by patients over the same period of time. The equation uses the average of the initial and final quantities and average of initial and final patient co-payments (i.e. price) for the base estimates.

$$E_d = \frac{\Delta Q / Q_{av}}{\Delta P / P_{av}}$$
$$E_d = \frac{(Q2 - Q1)/[(Q1 + Q2)/2]}{(P2 - P1)/[(P1 + P2)/2]}$$

$Q1$ is the number of cycles prior to the co-payment; $Q2$ is the number of cycles after the 50% co-payment; $P1$ is the price paid by patients for IVF and ICSI price before the co-payment; $P2$ is the price paid by patients after introducing the co-payment.

Since the variable $Q1$ is the quantity demanded prior to the policy change and $Q2$ is the quantity demanded after the policy, the change in IVF/ICSI volumes ($\Delta Q$) before and after the co-payment is first derived from $Q2$ to $Q1$. Because IVF/ICSI volumes decreased in response to introducing a co-payment, this results in a negative coefficient. The change in quantity is then divided by the average of the two quantities [$(Q1+Q2)/2$] to derive the average change in quantity ($Q_{av}$). A similar procedure is followed using the $P2$ and $P1$ price points to derive the change in price ($\Delta P$) and the average change in price ($P_{av}$). The elasticity of demand is then estimated from the ratio of change in quantity to the change in price.

## Assessing treatment substitution using cross-price elasticity

To assess how IVF and ICSI co-payments may influence demand for other fertility treatments, the cross-price-elasticity of demand method can be used. Cross-price elasticity evaluations are useful for highlighting how price changes for one treatment can influence treatment choices for other products or services. In our assessment, we looked at how introducing a 50% co-payment for IVF/ICSI influenced the demand for clomifene

### Table I IVF and ICSI annual cycle volumes used to estimate price-elasticities

| | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|
| IVF cycles[†] | 21 880 | 28 945 | 28 506 | 23 936 | 28 058 | 11 848 |
| ICSI cycles[†] | 21 224 | 15 752 | 24 897 | 37 692 | 51 389 | 25 339 |
| Clomifene[‡] | – | – | – | 131 529 | 126 037 | 124 814 |

Data reproduced with permission from Deutsches IVF Register (2004), www.deutsches-ivf-register.de.
[†]To adjust for variations in demand that occurred during the period prior to the co-payment introduction, we performed a secondary elasticity analysis using the average 5 year volumes for IVF and ICSI from 1999 to 2003. The average 5 year cycle volumes for IVF and ICSI used in the secondary analyses were 26 265 and 30 191, respectively.
[‡]Clomifene volumes are aggregated quarterly sales data provided by IMS Germany.

treatments. Using the cross-price elasticity of demand approach helps us to understand whether two products are substitutes for each other (i.e. interchangeable), complements of each other in that they are consumed together or consumed completely independent of one another. Although clomifene is not entirely interchangeable with IVF/ICSI, it is conceivable that price increases along a continuum of care could influence demand for treatments used early in the treatment pathway and outside of the control of gynaecologists.

The same formula used to calculate the price-elasticity of demand was used to calculate the cross-price elasticity for clomifene. The difference is that the change in patient demand was based on changes in clomifene sales volumes between 2003 (Q1) and 2004 (Q2) to derive $\Delta Q$ and $Q_{av}$ (Table I). The same co-payment changes $P2 - P1 = \Delta P$ for IVF/ICSI from January 2004 onwards were used in the denominator for estimating the cross-price elasticities. The convention applied to cross-price elasticities is that a positive (+) value indicates that two products are substitutes (i.e. can be interchanged), a negative (−) value suggests two products are complements and a ratio of zero or near zero indicates that patient demand for the two products are independent of one another. The annualized clomifene volumes were provided by IMS Germany and are shown in Table I.

### Patient co-payment changes

Prior to 2004, within the public reimbursement system couples were eligible for up to four IVF/ICSI cycles including pharmaceuticals, with 100% reimbursement. In January 2004, the German healthcare modernization law requires couples to pay 50% of all costs attributed to IVF/ICSI, including medicines (Gesundheitssystem-Modernisierungsgesetz, 2003). The cost per treatment cycle in 2004 varied between clinics, however, average co-payment estimates of approximately €1500 and €2000 per cycle for IVF and ICSI, respectively, have been reported by different sources (Schmeilzl and Krüger, 2006; Thaele and Uszkoreit, 2007). The increased costs faced by consumers were used to estimate the price-elasticities of demand for IVF and ICSI in relation to observed changes in demand. Indirect costs associated with consuming IVF/ICSI were not used in the calculations as there is unlikely to be any variation in these following the policy change.

## Results

The price elasticity of demand based on observed changes from 2003 to 2004 for IVF and ICSI were −0.41 and −0.34, respectively (Table II). Based on the average 5-year change prior to the 2004 policy reform, we estimated price-elasticities for IVF and ICSI at −0.38 and −0.09, respectively (Table I). The price-elasticity for IVF and ICSI together was −0.36 based on the 1 year comparison and

**Table II Price-elasticity of demand for IVF and ICSI following introduction of patient co-payments**

|  | Price elasticity (change from 2003 to 2004) | Price elasticity 5 year average (1999–2004) |
|---|---|---|
| IVF | −0.41 | −0.38 |
| ICSI | −0.34 | −0.09 |
| Combined IVF/ICSI | −0.36 | −0.21 |

−0.21 based on the combined 5 year average demand before the co-payment.

The cross-price elasticity for the demand in clomiphene treatment following the IVF and ICSI co-payment introduction was −0.01, suggesting no relationship in the demand curves for these products.

## Discussion

In this study, we report the short-run (12-month) price-elasticity of demand for fertility treatments following a policy change that resulted in the introduction of consumer co-payments for IVF and ICSI in Germany. Specifically, we demonstrate that introducing a co-payment resulted in elasticities of −0.41 and −0.34 based on changes in demand between 2003 and 2004 for IVF and ICSI, respectively, with a combined IVF/ICSI price-elasticity estimate at 1 year of −0.36. Because demand for IVF and ICSI is often dependent on the different causes of infertility attributed to females and males, respectively, it is likely that the combined elasticity estimates best reflects the price-elasticity of demand for couples.

One interpretation of our elasticity finding is that a 10% price increase for IVF and ICSI will result in a reduction in demand between 4.1 and 3.4% or 3.6% for IVF/ICSI combined. However, our findings are most likely applicable over the short-run based on a single price change from no fees to €1500−2000 over a 12-month period. It is important to note that over longer time periods, these observations may not hold true as a range of factors that can influence the supply and demand for fertility treatments are likely to change over time. Furthermore, the extrapolation of this finding to other markets is dependent on similar characteristics to those found in Germany such as treatment accessibility, living standards, disease perception and consumer costs, to name a few.

The standard convention applied to price-elasticity of demand estimates by economists would suggest that demand for IVF and ICSI are relatively inelastic. In other words, the percentage change in quantity demanded is less than the percentage change in price over the same period, and as a consequence demand is not associated closely with price changes for the price points tested (no fees to €1500−2000) over a 12 months period. Of course, this conclusion is implausible, given the 53% reduction in IVF/ICSI cycles within 12-months following the introduction of the co-payment, which suggests that demand is highly price-sensitive (Griesinger et al., 2007). The inelasticity of demand for IVF/ICSI that we describe can be explained by an even larger percentage increase in the price than the percentage reduction in services demanded. By convention, if demand for IVF/ICSI were 'elastic' (i.e. sensitive to price with elasticity $[E_d] > 1.0$) the reduction in treatment cycles (i.e. demand) following the co-payment introduction would have been much larger than was observed in 2004. In fact, in order to describe the demand for IVF/ICSI as elastic (i.e. $[E_d] > 1.0$) under the circumstances of an increase in cost starting at zero, there would have had to been almost a complete discontinuation of IVF/ICSI in 2004.

Previous studies have estimated price elasticities for IVF using international cost-per cycle comparisons and utilization rates in different countries (Collins et al., 1995; Chambers et al., 2009). Price-elasticities are ideally calculated when a price change occurs in isolation of other changes that are likely to influence demand, therefore allowing the possibility to measure the influence of price alone on changes in

demand. As identified in previous studies, when IVF elasticities are measured across different countries, it is difficult to account for the numerous differences in culture, access to services and disease perception that may exist between countries and influence demand for IVF and ICSI irrespective of price (Collins et al., 1995; Chambers et al., 2009). In our study, we have been able to isolate the effects of price by measuring changes in demand over a 12-month period immediately following the introduction of a patient co-payment in the same country when all other factors would have likely remained constant. Therefore our study could more accurately estimate the impact of introducing a co-payment on the demand for treatment than could a study which compares differences in service utilization and prices across different countries.

The elasticity results described in this article are consistent with research exploring the impact of price changes on demand in other areas of healthcare. The most common observation is that demand for healthcare is not responsive to price (i.e. inelastic) with elasticities normally <1.0 (Ringel et al., 2005). Reviewers of the elasticity literature also highlight that price is more likely to influence an individual's decision or ability to access treatment, rather than the frequency of visits once treatment has been accessed (Ringel et al., 2005). If this observation holds true for IVF/ICSI, then this might suggest that price increases can impact the number of people willing or able to access care and less so the number of treatment cycles per couple for those able to access treatment to begin with. The potentially discriminating effects of price increases that influence who can access fertility treatment based on ability to pay has obvious equity concerns (King and Meyer, 1997).

The cross-price elasticity for clomifene was near zero indicating that this low cost treatment was not being substituted for IVF and ICSI. Although most gynaecologists recognize that clomifene and IVF/ICSI are used in different populations, because they are often used along a continuum of fertility care, it was useful to see whether introducing a co-payment influenced treatment progression decisions for patients who may have commenced therapy on clomifene and previously would have advanced to IVF or ICSI. This is especially important because the prescription of clomifene often occurs outside of the control of gynaecologists and it is important to know how other prescribers may have responded to the IVF/ICSI co-payment change.

Dealing with an overnight introduction of cost for services, where $P1 = \text{€}0$, does not occur under normal market conditions and requires special considerations. For example, in this study $\Delta P$ will always be '2' as long as $P1 = \text{€}0$. This is a function of the accepted mid-point equation used and represents the upper limit of the changes in prices observed. Challenging the validity of the equation is beyond the scope of this article, and for this analysis we accept that the equation is valid and cite several references to support its application. However, we note that when substitute values, within reason, are used for $P1$ the main conclusions reported in this article do not change. Perhaps the significance of this debate is that it highlights the challenges in measuring changes in demand for IVF/ICSI in relation to price changes. It also highlights the need to better understand these relationships and how price signals influence consumer response, especially as it seems likely that increasing costs-to-patients will become more common for a wide range of medical procedures because of cost pressures arising from ageing populations and the introduction of expensive new technologies.

A limitation of this study is the inability to discriminate between the proportion of IVF/ICSI cycles delivered through the public system and those in the private insurance system. In this analysis, we used annual IVF and ICSI data provided by the DIR which includes aggregated public and private cycles. However, estimates suggest that the percentage of private cycles is approximately 10–20%, with the majority of cycles receiving public reimbursement (GBE, 2006; IGES, 2009). From January 2004, cycles performed within the public system were subject to the newly introduced co-payment, however, the policy change had no immediate bearing on costs within the private system. For IVF/ICSI cycles delivered through the private market, we are unable to establish how prices may have responded to the introduction of co-payments in the public system. Because public and private cycles are reported in aggregate, the changes in demand used to calculate the elasticities reported here likely reflects demand changes in the public system. This might suggest the demand change in the public market was even greater because demand was stabilized to some extent by privately reimbursed treatment cycles. For example, if private cycles were not included in the aggregated DIR data, then one might have expected to see an even greater reduction in the IVF/ICSI cycles conducted in the public sector.

A second weakness is that we are unable to establish whether price increases had a greater affect on first or subsequent attempts for conception using IVF/ICSI. This issue will be explored in future work.

## Conclusions

This study reports the price elasticity of demand following policy interventions that introduced patient co-payments for IVF and ICSI. By convention the price-elasticity results described here suggest that IVF and ICSI are price inelastic for the price points tested (no fees to €1500–2000) over a 12 month period, in that demand for treatment is relatively responsive to changes to price. This finding is mostly applicable over the short-run and is likely to vary over longer time periods as different factors that can influence the supply and demand for fertility treatments change over time. Additionally, the transferability of this finding is likely most applicable to industrialized countries with similar disease prevalence, accessibility to treatment, prevailing religion and similar economic conditions to those found in Germany. The major weaknesses of our study are the fact that our results are based on aggregated data and the inability to differentiate between private and public provision. Despite these weaknesses, we believe our elasticity estimates are a useful contribution to understanding the relationship between costs faced by consumers and demand for fertility treatments over the short-run.

## Authors' Role

M.P.C., Study concept and design, data analysis, interpretation of results, drafting and editing final manuscript. G.G., Study design, identification local data source, interpretation of results, writing and editing final manuscript. W.L., Study design, interpretation of results, drafting and editing final manuscript. M.J.P., Study design, methods selection, interpretation of results, drafting and editing final manuscript.

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