

Obtaining Required Data via Delphi Expert Opinion Surveys and Target Groups Surveys for Calculation of Financial Losses Resulted from Brucellosis and Cost-Benefit Analysis of Alternative Brucellosis Control Strategies in Turkey ^[1]

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Summary

This study aimed obtaining the data via Delphi Expert Opinion Surveys (DEOS) and Targeted Group Surveys (TGS) required for calculation of financial losses caused by *Brucella abortus* and *Brucella melitensis* in infected animals and humans and also required for performing cost-benefit analysis for different brucellosis control strategies in Turkey. DEOS performed in two rounds with 58 specialist veterinarians and medical doctors. TGS performed in one round with 18 livestock enterprises and 25 patients that has officially approved infection diagnosis. As a result of this study, it was determined that DEOS and TGS are extremely beneficial to obtain required data for financial and economical analysis of brucellosis that are not exist in literature and reports of authorized organizations or there are suspects on their credibility.

Keywords: Brucellosis, Delphi, Target group, Financial losses, Cost-benefit analysis, Turkey

Türkiye'de Bruselloz Kaynaklı Finansal Kayıpların Hesaplanabilmesi ve Alternatif Bruselloz Kontrol Stratejilerinin Maliyet-Fayda Analizlerinin Yapılabilmesi İçin İhtiyaç Duyulan Verilerin Delphi Uzman Görüşleri Anketleri ve Hedef Grup Anketleriyle Sağlanması

Özet

Bu çalışmada, Türkiye'de *Brucella abortus* ve *Brucella melitensis* kaynaklı enfekte hayvan ve insanlarda meydana gelen finansal kayıpların hesaplanması ve farklı bruselloz kontrol stratejilerinin maliyet-fayda analizlerinin yapılabilmesi için ihtiyaç duyulan verilerin Delphi Uzman Görüşleri Anketleri (DEOS) ve Hedef Grup Anketleri (TGS) yardımıyla elde edilmesi amaçlanmıştır. DEOS, konunun uzmanı 58 veteriner hekim ve tıp doktoru ile toplam 2 turda tamamlanmıştır. TGS, hastalığın resmi olarak onaylandığı 18 hayvancılık işletmesi ve hastalık tanısı konmuş 25 hastayla tek turda yapılarak tamamlanmıştır. Araştırma sonucunda, brusellozun finansal ve ekonomik analizi için ihtiyaç duyulmasına rağmen literatürde ve yetkili kurumların kayıtlarında bulunamayan veya güvenilirliğinden şüphe duyulan birçok verinin temininde DEOS ve TGS'nin kullanımının oldukça yararlı olduğu tespit edilmiştir.

Anahtar sözcükler: Bruselloz, Delphi, Hedef grup, Finansal kayıplar, Maliyet-fayda analizi, Türkiye

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INTRODUCTION

Brucellosis is widely-observed all over the world but more intensively through Mediterranean and Middle-East regions ¹. This zoonosis disease causes serious health problems for both animals and humans also it causes considerable financial losses ¹.

The scientific studies on economical and financial analysis of brucellosis which has high incidence and prevalence both in animals and human are needed in Turkey. In order to obtain reliable results for these studies primarily it is necessary to overcome the problems obtaining credible and current data.

The aim of this study are to obtain the data required for calculation of financial losses caused by *B. abortus* and *B. melitensis* in infected bovines, ovines and humans and also performing cost-benefit analysis for separate brucellosis control strategies via Delphi Expert Opinion Surveys (DEOS) and Targeted Group Surveys (TGS).

MATERIAL and METHODS

Most of the data required for this research obtained via DEOS and TGS. DEOS conducted in two rounds with 58 specialist veterinarians and medical doctors. TGS conducted in one round with 18 breeders and 25 patients that have officially approved brucellosis diagnosis in last 3 years. DEOS were carried out in Ankara, Sinop, Hatay, Balikesir and Igdir provinces which are located in 5 different geographical regions of Turkey. TGS were carried out in Ankara, Samsun and Kahramanmaraş which are located in 3 different geographical regions of Turkey.

Steps followed for this study listed as follows:

1. Scientific studies on basic characteristics of brucellosis like its epidemiology, symptoms, diagnosis, treatment, control and legal regulations for the disease were investigated and financial loss and expense items were determined.

2. In this step the basic mathematical equations formed to determine which data are required. Thereafter, DEOS and TGS forms prepared to obtain the required data which are unavailable in literature or there are suspects

on its credibility.

3. The specialist opinions acquired via sequential surveys of DEOS. For the first round answers of specialists IQR (Inter Quartile Range) calculated and the answers which were out of IQR determined. For each question 1st and 3rd quartile values attached in second round and asked the specialists to review their answers with respect to generally agreed opinions ^{2,3}.

4. In the last step, descriptive statistics performed for DEOS and TGS survey answers and the answers for same questions in two surveys of different kinds compared together. Finally, answers to be considered derived from DEOS and TGS determined in reference to the consistency and distribution of answers and rate of participants for questions.

RESULTS

DEOS Findings Concerning to Animal Production Losses

The specialist opinions on the subject of extended calving interval (ECI), extended age at first calving (EAFC), abortion, reformation, mortality, milk yield (MY) and live weight (LW) losses for a brucellosis infected animal are represented below.

As a results of DEOS, for an infected cow and heifer average ECI and EAFC were found 95 days (IQR: 70-120) and 110 days (IQR: 86-120) respectively.

As it is seen from *Table 1*, average abortion ratios were found 37% (40-3) in an infected cow and heifer, 40% (45-5) in an infected sheep and goat. Also, table indicates for cows and heifers brucellosis originated probabilities to be reformed is in average 23%, for sheep and goats it is in average 10%, mortality ratios for each species is 1%.

As it is seen from *Table 2*, MY and LW losses for bovines were determined 20% and 5% respectively and ovines 13% and 4% respectively.

DEOS Findings on Treatment, Control and Clinical Course of Brucellosis in Animals

Specialist opinions on treatment options, disease

Table 1. DEOS findings on brucellosis originated abortions and probability to be reformed and mortality

Tablo 1. Bruselloz kaynaklı abortlar ile reforme olma ve mortalite olasılıklarına ilişkin DEOS bulguları

Species	Descriptive Statistics	Generally Expected Abortion (%)	Brucellosis Originated Abortion (%)	Probability to be Reformed (%)	Mortality (%)
Cow and Heifer	Mean	3	40	23	1
	IQR	(2-5)	(30-60)	(6-48)	(0-2)
Sheep and Goat	Mean	5	45	10	1
	IQR	(3-7)	(30-55)	(0-50)	(0-3)

IQR: Inter Quartile Range

Table 2. DEOS findings on brucellosis originated MY and LW losses**Tablo 2.** Bruselloz kaynaklı süt verimi ve canlı ağırlık kayıplarına ilişkin DEOS bulguları

Species	Descriptive Statistics	Milk Yield Loss (%)	Live Weight Loss (%)
Bovines	Mean	20	5
	IQR	(10-21)	(0-10)
Ovines	Mean	13	4
	IQR	(10-20)	(0-10)

IQR: Inter Quartile Range

control and clinical course for infected animals with clear symptoms of brucellosis listed below.

Table 3 indicates DEOS findings on treatment options, periods and expenses in an infected animal which observed look alike brucellosis clinical symptoms.

Table 4 indicates for both species only 60% of the targeted population could be reached for routine vaccination programs; nevertheless with a nationally applied strict vaccination program it could be rise 90% for bovines and 80% for ovines. Ratios for officially

diagnosis of the disease were found in a very low level 10% for both species.

DEOS results also indicated that courses for an average of 40% (IRQ: 30-60) of infections are in clinical form and 60% of infections are in subclinical form.

DEOS Findings on Diagnosis, Treatment and Workforce Losses in Humans

By the light of DEOS findings it was observed that ratios for an correct diagnosis for an infected human apply to a medical organization for the first time was in average 35% (IQR: 16-50), pre-diagnostic wrong treatment was observed as 5 times (IQR: 3-8) per year. Ratios for a relapse in 1 year after treatment was found in average 13% (IQR: 10-15), relapse after treatment was observed as an average 2 times (IQR: 1-2). DEOS findings also demonstrates average workforce losses depending clinical and subclinical forms of brucellosis are 40% (IQR: 30-50) and 10% (IQR: 5-19) respectively.

Table 5 demonstrates that brucellosis diagnosed patients in the ratio of 80% took outpatient treatment and 20% involved in hospitalized treatment. The average

Table 3. DEOS findings on treatment options and expenses for an infected cow/heifer and sheep/goat**Tablo 3.** Enfekte düve/inek ile koyun/keçide tedavi seçenek ve harcamalarına ilişkin DEOS bulguları

Species	Descriptive Statistics	Probability of to Start the Treatment (%)	Prob. of the Treatment Applied by A Specialist (%)	Rate of Relapses After Treatment (%)	Average Period of A Treatment (Day)	Veterinary Expenses (\$)	Breeders Expenses (\$)
Cow and Heifer	Mean	80	68	50	7	92	46
	IQR	(60-80)	(60-80)	(25-51)	(5-9)	(67-100)	(33-50)
Sheep and Goat	Mean	65	48	40	4	2	1
	IQR	(50-80)	(30-69)	(20-63)	(1-5)	(1-4)	(1-2)

IQR: Inter Quartile Range

Table 4. DEOS findings on official diagnosis, vaccinations and screening tests of brucellosis**Tablo 4.** Brusellozun resmi teşhisi, aşılama ve tarama testlerine ilişkin DEOS bulguları

Species	Descriptive Statistics	Targeted Population Attained in Routine Vaccinations (%)	Rate of Attainable Population If Would Apply Nationally Planned Screening Tests (%)	Rate of Officially Diagnosis of Brucellosis (%)
Bovines	Mean	63	90	10
	IQR	(48-80)	(80-90)	(5-15)
Ovines	Mean	60	80	10
	IQR	(39-80)	(78-90)	(9-20)

IQR: Inter Quartile Range

Table 5. DEOS findings on brucellosis infected outpatient and hospitalized treatment**Tablo 5.** Brusellozla enfekte ayaklı ve yataklı hastaların tedavilerine ilişkin DEOS bulguları

Infected Case	Descriptive Statistics	Probability of Outpatient Treatment (%)	Probability of Hospitalized Treatment (%)	Duration of Outpatient Treatment (Days)	Duration of Hospitalized Treatment (Days)
Patient	Mean	80	20	44	12
	IQR	(70-90)	(10-30)	(42-45)	(10-14)

IQR: Inter Quartile Range

duration of outpatient and hospitalized treatment were determined respectively 44 and 12 days.

DEOS Findings on Number of Yearly Disease Outbreaks and Success of Brucellosis Control Applications

Specialist opinions on number of yearly disease outbreaks originated from *B. abortus* and *B. melitensis* infections and also success levels of disease control applications demonstrated below.

Table 6 shows number of yearly disease outbreaks for both species are seen most in East and South-East regions and number of observed outbreaks in all regions for bovines and ovines 1100 and 625 respectively.

Table 7 demonstrates the opinions of veterinarians and medical doctors on the success of their organizations against brucellosis.

TGA Findings in Brucellosis Outbreak Zones Obtained from Breeders

Breeders' opinions about brucellosis effects on certain efficiency, yield and treatment characteristics and alternatives in an infected animal demonstrated below.

As it could be derived from Table 8, infection causes

a delay on calving period for 63 days in cows and milk production loss 8%; also indicated the probability to be reformed for an ovine determined as 35%. Brucellosis originated abortion ratios for bovines and ovines determined in average 75% and 16% respectively.

As Table 9 represents, probability of treatment for an infected cow or heifer is 25%, sheep or goat treatment probability is 82% and relapse observed for half of ovines. Cost of treatment by veterinarians determined as an average of \$83 for cows/heifers and \$1.5 for ovines.

TGA Findings obtained from Brucellosis Infected Patients

As seen in Table 10, period for pre-diagnostic complaints lasts for an average of 38 days; false treatments arise from non specific symptoms applied to patients averagely 2 times a year and each takes a period of 7 days. TGS also reveals relapses occurs averagely once a year (IQR: 1-1) in proportion of %33 (standard deviation found as 47).

Table 11 represents an average of 72% of brucellosis infected patients take outpatient treatment and an average of 28% (100% - 72%) involves in hospitalized treatment; average durations for these treatments takes 45 days and 11 days respectively.

Table 6. DEOS findings on number of brucellosis originated yearly disease outbreaks in different regions of Turkey

Tablo 6. Türkiye'nin farklı bölgesinde bruselloz kaynaklı yıllık mihrak sayılarına ilişkin DEOS bulguları

Species	Descriptive Statistics	East and South East Anatolia Region (Number)	Central Anatolia and Mediterranean Region (Number)	Aegean and Marmara Region (Number)	Black Sea Region (Number)
<i>B. abortus</i>	Mean	1100	1025	500	300
	IQR	(800-2200)	(463-1500)	(300-600)	(180-500)
<i>B. melitensis</i>	Mean	625	400	225	150
	IQR	(431-800)	(308-613)	(100-303)	(100-200)

IQR: Inter Quartile Range

Table 7. DEOS findings on success of brucellosis control activities applied in Turkey in the field of animal and human health

Tablo 7. Türkiye'de hayvan ve insan sağlığı alanında uygulanan bruselloz kontrol faaliyetlerinin başarısına ilişkin DEOS bulguları

Occupations	Very Successfull	Successfull	Partially Successfull	Unsuccessfull
Veterinarians	0%	3%	41%	56%
Medical Doctors	0%	16%	68%	16%

Table 8. TGS findings about certain yield characteristics in an infected animal

Tablo 8. Enfekte bir hayvandaki bazı verim özelliklerine ilişkin TGS bulguları

Species	Descriptive Statistics	Extended Calving Interval (Days)	Probability to be Reformed (%)	Brucellosis Originated Abortion (%)	Milk Yield Losses (%)	Live Weight Losses (%)
Bovines	Mean	63	/*/	75	8	/*/
	IQR	(42-63)		(50-98)	(0-31)	
Ovines	Mean	-	35	16	/*/	
	IQR		(8-100)	(15-30)		

IQR: Inter Quartile Range

/*/ : Data required for statistical analysis could not be obtained

Table 9. TGS findings about treatment options and costs in an infected animal**Tablo 9.** Enfekte bir hayvandaki tedavi seçenekleri ve maliyetlerine ilişkin TGS bulguları

Species	Descriptive Statistics	Beginning Treatment (%)	Relapse after Treatment (%)	Veterinarians Treatment Expenditure for An Infected Animal (\$/Head)
Bovines	Mean	25	/*/*	83
	IQR	-		(66-175)
	SD	45		-
Ovines	Mean	82	50	1.5
	IQR	-	-	(1-4)
	SD	38.6	50	-

IQR: Inter Quartile Range

SD : Standard deviation. (Its used by reason of characteristic of answers)

/*/* : Data required for statistical analysis could not be obtained

Table 10. TGS findings on pre-diagnostic term and treatment duration**Tablo 10.** Tanı öncesi dönem ve tedavi süresine ilişkin TGS bulguları

Infected Case	Descriptive Statistics	Period for Pre-Diagnostic Complaints (Days)	Pre-Diagnostic False Treatments in A Year (Number)	Average Period for A False Treatment (Days)
Patient	Mean	38	2	7
	IQR	(12-101)	(1-4)	(4-10)

IQR: Inter Quartile Range

Table 11. TGS findings on duration of treatments and workforce losses in outpatient and hospitalized patients**Tablo 11.** Ayaklı ve yataklı hastalarda tedavi süresi ve işgücü kayıplarına ilişkin TGS bulguları

Infected Case	Descriptive Statistics	Ratio of Outpatient Treatment (%)	Duration of Outpatient Treatment (Days)	Duration of Hospitalized Treatment (Days)	Workforce Loss in An Outpatient (%)
Patient	Mean	72	45	11	50
	IQR	-	(39-68)	(10-17)	(0-100)
	SD	44.8	-	-	-

IQR: Inter Quartile Range

SD: Standard deviation (SD used by reason of characteristic of answers)

DISCUSSION

General Assessment of Questionnaires

DEOS were used for financial analysis of foot and mouth diseases by Senturk and Yalcin² for the first time in Turkey. This is the first time DEOS and TGS used together for this study on brucellosis financial analysis.

Usage of both two survey types with similar questions enabled this study to compare the experiences of veterinarians and breeders; medical doctors and patients. Therefore using TGS and DEOS together made possible to control the reliability of our findings and also it raised the accuracy of data obtained.

Evaluation of Animal Production and Efficiency Losses

- **Milk Yield (MY) and Live Weight (LW) Losses:** Yearly MY losses for a brucellosis infected cow determined by

studies of Meyer⁴, Hugh-Jones et al.⁵, Carpenter⁶ Shepherd et al.⁷, Gomez⁸, Murillo⁹, Bernues et al.¹⁰ and Eskiizmirli¹¹ in values between 10% to 25%. Anon¹² stated minimum MY loss for infected animals should be 10% and Yurtalan¹³ reported the maximum loss could be 20%. While DEOS result on MY losses for bovines is 20% in accordance with literature, TGS result is low with 8%. No literature statements observed on MY losses for sheep and goats in which by DEOS determined as 13%.

While LW losses in infected bovines stated as 5% by Bernues et al.¹⁰, Eskiizmirli¹¹ argued this loss could be in a value approximate to 30%. In accordance with Barneus et al.¹⁰, DEOS findings indicated a value of 5%. No literature statements observed on LW losses for sheep and goats in which by DEOS determined as 4%.

- **Extended Calving Interval (ECI) and Extended Age at First Calving (EAFc):** While ECI for an infected cow after abortion determined by Hugh-Jones et al.⁵ as 63 days, Iyisan et al.¹⁴ stated this period could take months. In the

light of DEOS and TGS results, ECI for cows determined respectively as 95 days and 63 days. For while the period of conducting the surveys it was observed, the breeders' observations and opinions on cows seeding periods more appropriate, only TGS result (63 days) can be taken into account. Because of the no literature statements observed on EAFC, could not be made a any assessment on this matter.

- **Abortion Losses:** Brucellosis originated abortion losses for a cow determined by Arda et al.¹⁵ as 80% for recently infected cow and depending on level of chronic situation 25-50%; by Anon¹² in ratios 30-80%; by Hugh-Jones et al.⁵, Carpenter⁶, Shepherd et al.⁷, Gomez⁸, Murillo⁹, Barneus et al.¹⁰ and Muma et al.¹⁶ as in ratios %10 to %50.

While DEOS results indicated brucellosis originated abortion ratios for bovines were 37%, for small ruminants 40%; according to TGS results the ratios were found respectively 75% and 17%. Despite the results obtained by DEOS and TGS were quite different from each other, both results are in accordance with literature. Nevertheless, abortions are the most prominent symptoms for infection and breeders could easily observe this symptom. Also breeders answered the question about abortions in accordance and all of them attended to this question. For these facts, on this subject only TGS results can be take into account.

- **Reformation and Mortality Losses:** Reformation ratios after abortion determined as 20% by Hugh-Jones et al.⁵, Carpenter⁶ emphasized it as 15% for positive animals.

As results of DEOS, reformation ratios was found for an infected animal, for a cow and heifer 23% and for a sheep and goat 10%. For ovines TGS indicated 35% for the ratio of reformation, for cows and heifers the data required for statistical analysis could not be obtained. DEOS result for brucellosis originated mortality as 1% is in accordance with finding of Gomez⁸ as 1%.

Assessment of Findings on Treatment, Control and Clinical Course of Brucellosis in Animals

- **Treatment of Disease:** Brucellosis treatment of animals in farms is not suggested by reason of it is not economical. Also though the treatment be able to eliminate the symptoms, the infected animals still remains as infection sources. Nevertheless, it is known that the treatment or at least vaccination are applied for brucellosis like clinical cases, like metritis and retentio secundinarum.

- **Control and Clinical Course of Disease:** For the answers of the questions under this title requires specialist knowledge and experience, only DEOS surveys used.

In our opinion, the reasons of low ratio of attainment as 60% for vaccination program are risks of vaccination relating to human health and lack of supportive payments.

The optimistic estimation of 80%-90% attainment for a possible country-wide screening test could be only explained under conditions, compensation payments and well presentation applied.

DEOS findings also indicated with an average ratio of 60% brucellosis is observed as an asymptomatic (sub-clinical) clinical course; this could be explained by the general clinical symptoms of the disease which are abortion and infertility (not specific for brucellosis).

Evaluation of Findings on Diagnosis, Treatment and Workforce Losses in Humans

- **Diagnosis and Treatment:** DEOS findings indicated that the ratio of correct diagnosis of brucellosis for first step medical organizations on patients applied for the first time is 35%. This situation demonstrates brucellosis with unspecific symptoms could be missed. However, university and research hospitals could properly diagnose the disease for most of the patients sent to them. The reasons for this are, patients who sent to these hospitals already has complaints in accordance with brucellosis symptoms and laboratory analysis could be done in a wider scope in this hospitals.

Cengiz¹⁷ observed that before a certain diagnosis, period patient complaints about the disease symptoms could be in a wide differential between 8 days to 180 days. With TGS findings, this period determined according to Cengiz¹⁷ as 38 days. Because of the workforce losses originated from nonspecific disease symptoms, this period is very important.

DEOS and TGS findings indicates, the number of incorrect treatments applied for a period of 1 year respectively as 5 and 3 times. TGS findings can be take into account for this question because of approximately all of patients answered the question and these answers were in accordance with each other. The 7 days period of treatment based on a incorrect diagnosis derived from patient surveys is in accordance with a period of a regular antibiotic treatment against nonspecific brucellosis-like symptoms.

Treatment of doxycycline + rifampicin for 6 weeks (42 days) which WHO suggests, except for the complications like spondylitis, endocarditis, meningitis, is in accordance with the answers to DEOS and TGS which are respectively 44 and 45 days. Average outpatient treatment period of 11 and 12 days which were respectively obtained by DEOS and TGS are in accordance. Because of the no literature statements observed on outpatient treatment, could not be made any assessment on this matter.

The ratios obtained by DEOS and TGS about outpatient and hospitalized treatments are in accordance which are for DEOS 80% and 20% respectively and for TGS 72% and 28% respectively. No relevant literature statement

found on these data. The reason for the ratio of outpatient treatment is much too higher for DEOS and TGS is thought as, without a serious organ involvement, hospitalized treatments does not applied.

Relapse ratios after treatment which are 13% in Cengiz¹⁷ 5%-13% in Sirmatel¹⁸ and 15% in Alptekin and Bilgiç¹⁹ are in accordance with DEOS findings which is 13%. TGS findings can be take into account which are discordant to literature with a ratio of 33% because of patients lived through infection and their answers were consistent with each others.

- **Workforce Losses:** DEOS and TGS findings indicated acute and sub-acute brucellosis originated workforce losses respectively as 40% and 50% when compared with healthy period. TGS results considered because of the fact that patients lived through that experience. It is determined that the workforce losses increases for heavy works which require more human efforts. For hospitalized patients the workforce loss considered as 100%.

Assessment of Findings on the Number of Cases and Outbreaks and Success of Disease Control Applications

Owing to the fact that the answers required knowledge of a specialist, only DEOS results considered under this title.

When compared with Ministry of Agriculture and Rural Affairs' (MARA) formal reports for 2008, survey results (2925 for *B. abortus*, 1400 for *B. melitensis*) indicated 5 times more outbreaks number for *B. abortus* and 7 times more outbreaks number for *B. melitensis*²⁰. Specialist opinions of widely observed brucellosis indicate that the announcements for disease outbreaks are inadequate and the targets aimed for fight with disease could not be reached successfully. The main reasons for this could be listed as: long period for formal and bureaucratic processes in disease outbreaks zone, technical and economical inadequacy of MARA, apathy of breeders and characteristics of disease clinical course which is generally asymptomatic.

For different regions, most outbreaks were observed in East and South-East Anatolian Regions with 37.6% *B. abortus* originated and 44.6% *B. melitensis* originated. The main reasons for this could be poor socio-economical condition of these regions and non-controlled animals movements.

While the ratio of veterinarians that are in opinion of partially or completely success of presently applied protection and control strategies is 44%, medical doctors in this opinion are 84%. The main reason for medical doctors ascribes more success for their organizations could be explained with better financial and technical facilities they have.

There are still problems in obtaining required data to determine the animal infections based economical and financial losses as it was. Conducting several surveys such as DEOS and TGS are the important way to obtain required data that related organization has not declared any; and also it is the best way to eliminate suspected data and obtain better results, healthy ones.

Results of these study indicated the data required to determine brucellosis originated financial losses and to perform financial analysis for disease control strategies DEOS and TGS are extremely beneficial. It is determined that for further studies performing financial or economical analysis for diseases the mentioned surveys will make a major contribution.

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